Vol. 15 MAY, 1932 No. 5

Journal
of the
American Ceramic Society

Abstracts
Vol. 11, No. 5

Bulletin
Vol. 11, No. 5

A Monthly Journal Devoted to the Arts and Sciences
Related to the Silicate Industries

Publication Office: 10th & Northampton Sts., Easton, Pa.
Editorial and Advertising Offices: 2525 N. High St., Columbus, Ohio.
Executive Office: 2525 N. High St., Columbus, Ohio.
Committee on Publications: J. T. Littleton, Chairman; L. Navias, L. J. Trostel, A. E. R. Westman, Ross C. Purdy.
Entered as second class matter at the post office at Easton, Pa., under the Act of March 3, 1879.
(*Copyright 1932, American Ceramic Society*)
Subscription Fifteen dollars a year. Single numbers one dollar and one-half
(*Foreign and Canadian postage, 50c additional on subscriptions*).

Established 1869

B. F. DRAKENFELD & CO.

Incorporated

45-7 Park Place New York

Color Specialists to the Ceramic Industry since 1869

OXIDE COLORS

FOR ENAMELERS

Manufactured Throughout under Strict Chemical Control

SPECIAL AND UNIQUE COLOR SHADES

Prepared to Meet Individual Requirements

Order Direct or through Following Agents

FERRO ENAMEL SUPPLY CO.
CLEVELAND, OHIO

BRAUN CORPORATION
LOS ANGELES, CALIF.

BATCH PLANTS

LEHRS

OLD STUFF for SIMPLEX to create designs that give fine results

TANKS

FURNACES

Simplex engineers are at your service without obligation

SIMPLEX ENGINEERING COMPANY
Washington Trust Building
Washington, Pennsylvania, U. S. A.

Of Value to You
is our
Long Record
of
Plant Proven Dependability
for
Constancy in Quality
due to
Laboratory Controlled Inspection
and
Nature's Most Uniform Deposits
of
Ball, Sagger, Enamel, Wad and Fire CLAYS

Mined and Sold by

KENTUCKY-TENNESSEE CLAY COMPANY
Mayfield, Kentucky

(When writing to advertisers, please mention the JOURNAL)

DRYERS

Savings Guaranteed

When installing new equipment we definitely guarantee savings in power, labor and spoilage.

"Hurricane" Dryers are made in Truck, Tray and Automatic types for all ceramic products, including pottery, abrasive wheels, bricks, tile, spark plugs, insulators, etc.

THE PHILADELPHIA DRYING MACHINERY CO.
3351 STOKLEY STREET
PHILADELPHIA, PA.

260

BORAX
AND
BORIC ACID

* * *

GUARANTEED
OVER 99½% PURE
AMERICAN POTASH & CHEMICAL CORPORATION
Woolworth Bldg., New York City

Refractory Materials

Products of the Electric Furnace

SILICON CARBIDE
SILICON CARBIDE FIRESAND
ARTIFICIAL MULLITE
FUSED ALUMINUM OXIDE
FUSED MAGNESITE

Furnished in raw material form, ground to meet specifications.

Our Research Department with fully equipped laboratories is always at your service.
WRITE US ABOUT YOUR PROBLEMS

THE EXOLON COMPANY

Established 1914

Electric Furnace Plant { THOROLD, ONTARIO
Finishing Plant, General Offices { BLASDELL, N. Y.

Table of Contents

MAY, 1932

The Journal

The Production and Control of Copper Reds in an Oxidizing Kiln Atmosphere—Baggs and Littlefield ... 265
A Copper Blue at Cone 9—Littlefield ... 269
An Experiment in Egyptian Blue Glaze—Binns, Klem, and Mott ... 271
Results of Tests on Ten Demonstrations of Reinforced Brick Structures with Summary Covering Tests on Thirteen Structures—Krauss and Vogdes ... 273
Method of Testing Reinforced Brick Masonry Demonstration Structures—Krauss and Vogdes ... 300
Preliminary Outline of Program of Research in Reinforced Brick Masonry—Krauss and Vogdes ... 305
Tentative Specifications for Reinforced Brick Masonry. I. Tentative Specifications—Krauss and Vogdes ... 313

Ceramic Abstracts 285

The Bulletin

Editorials
Prepare for Critical Markets ... 107
A New Use for Enamelware ... 108

Papers and Discussions
A Laboratory Test for the Hardness of Sandblast Sand—Poste ... 110
The Motion Picture as an Aid to Refractories Research—Curtis ... 114

Activities of the Society
Special Announcements ... 124
Announcement by Chairman of Fellows ... 125
Minutes of Meeting of Executive Committee, Board of Trustees, AMERICAN CERAMIC SOCIETY, April 8, 1932 ... 125
Meeting of the Joint Committee on Foundry Refractories ... 127
Report of Enamel Division Standards Committee—Kinzie ... 130
Acid Resistance of Enamelware ... 134
Qualitative Spot Test for Resistance of Enamelware to Acids—Gautsch ... 138
Condolence from Organizations Abroad on the Passing of General Orton ... 138
Local Section News:
Baltimore-Washington Section ... 139
Pittsburgh Section ... 139
New Members Received in February and March ... 140
Roster Changes for February and March ... 140
Necrology
S. M. Kier ... 141
Burrows Sloan ... 141
Mrs. E. W. Washburn ... 142

Notes and News
G. E. F. Lundell Receives Hillebrand Award ... 142
Here Is an Enterprising Ceramic School—Isenhour ... 142

Calendar of Meetings ... 144

Advertisers' Index ... 13

The peace that pennies buy

EACH DAY, after breakfast, you bid goodbye to your husband and he is gone. Miles of distance and hours of traveling may separate him from you, yet you do not fear. You have no feeling of his being far away—no sense of loneliness or isolation. For there, within reach of your hand, is your contact with all the world—the guardian of your home . . . your telephone.

All you see is the telephone instrument itself and a few feet of wire. Through the familiarity of use, you are likely to take it for granted in much the same manner as air and water and sunshine. Rarely do you think of the complicated exchanges, the almost endless stretches of wire and the hundreds of thousands of trained employees that are needed to interconnect, through the Bell System, nearly twenty million telephones in this country and twelve million in foreign lands. No matter where you are you can command the full use of the telephone. It knows no class or creed. There is no distinction of position. All may share it equally.

Every time you lift the receiver you employ some part of the nation-wide Bell System. Yet the charge for residential use is but a few cents a day. For this small sum you receive a service that is almost limitless in convenience and achievement—so indispensable in emergencies that its value cannot be measured in terms of money.

Thinking of the peace and security it brings each home—of hurried calls to doctors and hospitals—of priceless, necessary talks with relatives and friends—of the many ways it saves you steps and time and trouble throughout the month, you will know why so many millions of people look on the telephone as a member of the family.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

(When writing to advertisers, please mention the JOURNAL)

THE PRODUCTION AND CONTROL OF COPPER REDS IN AN OXIDIZING KILN ATMOSPHERE*

By Arthur E. Baggs and Edgar Littlefield

ABSTRACT

Experiments are reported demonstrating the possibility of producing localized, definitely controlled effects of reduction, in oxidizing or neutral kiln atmospheres, through the use of glazes or slips of special composition. This control was obtained by two methods as follows: (1) by incorporating silicon carbide in the glaze batch and (2) by introducing silicon carbide into underglaze slips. In ordinary kiln atmospheres both methods produced satisfactory results in which predetermined areas of copper reds and copper blues or greens were developed on the same piece.

I. Introduction

Copper is a colorant familiar to every ceramist. While normally used in the production of green and blue glazes, under reducing conditions its possibilities extend to lavenders, reds, and purples of almost infinite variety, depending upon many factors in glaze composition and firing conditions. The Chun pottery of the Sung dynasty in China is prized because of the beautiful color effects obtained with copper. These colors range from sky blue through lavenders and purples of almost every shade, to red.

To the casual observer these splashes of brilliant color may appear to be accidental, due to a slightly reducing atmosphere in the kiln. This is undoubtedly true in a great many cases. There are in existence, however, many specimens of Chun ware which exhibit a definite purpose of design in placing the colored splashes, thus indicating that the ancient Chinese potter could, if he desired, confine the reduction to a small area on a piece of pottery. Since the reduction was confined to a small predetermined area on a piece, it is extremely difficult to conceive of its being accomplished by manipulation of the kiln atmosphere. The obvious conclusion is that it was done by the local application of some glaze which, because of its composition, was more susceptible to reduction.

Writers on Chinese ceramics agree that glazes of the transmutation type were fired under reducing conditions and they do not suggest the possibility of the Chinese potters having attained their results in an oxidizing kiln atmosphere.

To the authors' knowledge ceramic literature contains no reference to a method of producing and controlling copper reds in an oxidizing kiln atmosphere. This paper is a sketch of a series of experiments directed along that line.

---

* Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Art Division). Received March 18, 1932.

II. The Glaze

The glaze selected as the starting point in the experiments was one which under oxidizing conditions gives a color varying from sky blue to turquoise, depending upon the copper content. The molecular formula is

$$\left.\begin{matrix} 0.8\ Na_2O \\ 0.2\ CaO \end{matrix}\right\} \quad 0.25\ Al_2O_3 \quad 3.75\ SiO_2$$

This glaze was selected because in previous firings it had shown itself to be very susceptible to reduction. Other ingredients were added to the glaze batch as needed. The glaze was not fritted, the soda being added as powdered sodium silicate.

III. The Reducing Agent

In the choice of a reducing agent, it was necessary to select one which would introduce nothing detrimental to the color and texture of the glaze. This suggested some form of carbon.

Lampblack and graphite were tried by painting them over parts of tile covered with glaze containing 5% of copper carbonate and firing to cone 9 in 50 minutes in a Méker furnace. They were not satisfactory because they oxidized at comparatively low temperatures, so that by the time cone 9 was reached their effect was dissipated. Lampblack and graphite were also tried, mixed with the glaze. By this method it was possible to secure some reduction but the results were so erratic that it was thought advisable to seek some other form of carbon.

The next reducing agent tried was silicon carbide. This material was mixed with the glaze and looked promising from the first trial made with it. Spots of glaze containing silicon carbide were applied on areas of glaze containing no silicon carbide and the tests were fired to cone 9 in the Méker test furnace. The color of the applied spots was a dark reddish brown, flecked with black, the ground color remaining blue. All the trials made with silicon carbide were consistent and it was chosen as the reducing agent for the remainder of the tests.

IV. The Adjustment of the Silicon Carbide and the Glaze

In the first tests 3% of silicon carbide was added to the glaze batch. This was gradually reduced to 0.2 of 1% with no apparent loss in the effectiveness of the reduction, but the color remained an ugly reddish brown. It was suspected that the copper content was too high. The amount of copper carbonate was reduced by stages with improving results until at 0.3 of 1% copper carbonate a brilliant red was obtained. These reds were mottled and somewhat obscured by the tin oxide in the glaze. Trials made with no tin oxide were blackish with only traces of red. It was

therefore thought advisable not to eliminate the tin altogether. Trials made with 1% of tin oxide added to the glaze batch gave the most promising series of reds yet obtained in the experiment.

(1) Large Scale Trials After it was sufficiently demonstrated that reds and blues of copper could be produced on the same piece at the same firing in a small muffle furnace, the next step was to fire a set of trials in a larger kiln under oxidizing conditions approximating those of commercial production. Accordingly, a series of trials was made up incorporating all of the most favorable factors found in the previous tests. White earthenware bowls were covered with a copper glaze containing no silicon carbide and over this were applied splashes of glaze containing silicon carbide. The tests were fired to cone 9 in 24 hours in an oxidizing kiln atmosphere. The red color developed only on the intended areas with no trace of reduction on the blue portions. The most brilliant reds were obtained where the red glaze had flowed slightly.

V. Improved Texture

To improve the texture of the glaze it was modified through a series of experiments until the following molecular formula was reached:

$$\left.\begin{matrix}0.3\ Na_2O\\0.3\ K_2O\\0.4\ CaO\end{matrix}\right\}\ \left.\begin{matrix}0.6\ Al_2O_3\\0.4\ B_2O_3\end{matrix}\right\}\ \left\{\begin{matrix}4.0\ SiO\end{matrix}\right.$$

16.5	raw borax
5.55	SS-20 powdered sodium silicate
36.06	feldspar
8.63	whiting
16.70	kaolin
16.50	flint
99.94	

For the red glaze, batch additions of 0.3% copper carbonate, 1% silicon carbide, and 1% stannic oxide were made.

For the blue glaze to be used as a background for the red glaze, batch additions of 5 to 7% stannic oxide and 0.3 to 1 % of copper carbonate were made.

VI. An Underglaze Reducing Agent

A second method of producing controlled areas of reduction was tried by introducing silicon carbide into slips for use under glazes containing copper. Two slips were used in these experiments.

VII. Low Temperature Slip

Slip A designed for temperatures under cone 2 was composed of the following ingredients:

Godfrey feldspar	50	English china clay	10
Bone ash	20	Bentonite	3
English ball clay	12	No. 8 flux*	10

* No. 8 flux is a commercial frit of approximately the following composition: flint 16.67, borax 33.33, and red lead 50.00.

This slip became strongly attached to the body on which it was applied at as low a temperature as cone 06 and was satisfactory up to cone 2. Silicon carbide was added to the slip in amounts ranging from 1 to 10%. Stripes of these mixtures were applied on biscuit tile and on green ware. They were fired on at cone 06.

Over this series of tests two low temperature glazes were applied and the tests were fired at cone 012 in a small electric furnace. The glazes were as follows:

(1)	No. 8 flux*	100	(2)	Calcined borax	19.0
	Tin oxide	2		SS-20 powdered sodium silicate	72.0
	Copper carbonate	1		Whiting	9.0
					100.0
				Copper carbonate	2.0

* See footnote, page 267.

Glaze (1) is light green in color; glaze (2) is a bright blue.

The test pieces showed reds of varying strengths on nearly all of the slip-covered areas, while outside those areas the characteristic green or blue color of the glaze remained.

VIII. Slips at Cone 9

A second series of slip tests was prepared for higher temperatures. A white earthenware body was used as a base slip with additions of silicon carbide varying from 0.5 to 2.5%, it being evident from the first tests that higher percentages of silicon carbide were not necessary. These were applied as before to biscuit tile and in areas of incised decoration on green ware. They were biscuit-fired at cone 3 and glazed with a transparent glaze maturing at cone 9 and containing small percentages of tin oxide and copper carbonate. These tests also showed a consistent development of reds over the slip-covered areas. Even in the finer details of the incised patterns the red was sharply brought out, indicating satisfactory possibilities of control.

The glaze used was as follows:

Feldspar	40.0	Whiting	18.0
Flint	40.0	Copper carbonate	0.6
Borax	12.0	Tin oxide	2.0

IX. Tentative Deductions

Without going into detail as to the evidence from which they were deduced certain guesses may be made regarding the action of silicon carbide in underglaze slips.

(1) Apparently silicon carbide introduced in a slip remains virtually inert until actual fusion develops either in the slip or in the glaze which is in contact with the

slip. In the biscuit fire at stages below vitrification even so little as 0.5% silicon carbide seems to remain unchanged.

(2) As soon as the slip comes into contact with a fusing glaze the silicon carbide begins to react causing local reduction. During this stage more or less violent boiling is evident which subsides as the reducing agent becomes exhausted. The glaze at some point reaches a state of quiet fusion while still in a reduced condition. If the firing is carried too far beyond this point the red color seems to volatilize and colorless glaze remains where the red has been.

The vital point then seems to be to proportion the amount of the reducing agent coming in contact with the fusing glaze so that its power shall be fully spent just before or almost identically at the maturing temperature. When this is accomplished fine reds result. When too much reducing agent is present, the firing temperature too low, or the firing period too short, bubbly, blistered glazes are produced with colors tending toward brown or black. When too little reducing agent or too long or too high fire occurs the red color burns out leaving colorless patches on the blue or green ground of the unreduced portion of the piece.

X. Conclusions

The following conclusions are drawn from these experiments:

(1) It is possible and feasible to produce reds of copper in an oxidizing kiln atmosphere by the use of a reducing agent incorporated in the glaze batch or in a slip under the glaze.

(2) It is possible to control the areas of reduced and oxidized glaze on a piece.

(3) Silicon carbide functions as a satisfactory reducing agent for the production and control of copper reds in an oxidizing kiln atmosphere.

CERAMIC ART DIVISION
FINE ARTS DEPARTMENT, O. S. U.
COLUMBUS, OHIO

A COPPER BLUE AT CONE 9*

BY EDGAR LITTLEFIELD

I. Introduction

Copper blue glazes at low temperatures are by no means novel for the ancient potters of Egypt and Persia have shown the exquisite ceramic colors thus obtainable. Moreover, their method of production is familiar to modern ceramists, but relatively little work on the blue of copper has been done in the high temperature field. This paper describes briefly the development of such a glaze at cone 9.

---

* Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Cleveland. Ohio, February, 1932 (Art Division). Received March 18, 1932.

II. Plan of Investigation

Three glazes were made up as follows:

$$A\begin{cases}0.8\ Na_2O\\0.2\ CaO\end{cases}\ 0.0\ Al_2O_3\ \ 6.0\ SiO_2 \qquad B\begin{cases}0.8\ Na_2O\\0.2\ CaO\end{cases}\ 0.0\ Al_2O_3\ \ 3.0\ SiO_2$$

$$C\begin{cases}0.8\ Na_2O\\0.2\ CaO\end{cases}\ 0.5\ Al_2O_3\ \ 3.0\ SiO_2$$

The soda was added as powdered sodium silicate (SS-20); 5.5% of copper carbonate was added to each glaze batch.

III. Results

Triaxial blends were made of these glazes and the trials were fired on white earthenware bowls to cone 9 in 24 hours. The best member of the triaxial system had the molecular formula of

$$\begin{matrix}0.8\ Na_2O\\0.2\ CaO\end{matrix}\ 0.25\ Al_2O_3 - 3.75\ SiO_2$$

This member was a good blue bright glaze and was not devitrified. Members containing less than 0.25 equivalent of alumina were devitrified. An alumina content as high as 0.4 equivalent had little effect on the blue color. High silica tests had the best blue color but were immature. All members crazed badly.

A series of tests was made up to find out how much lime could be used without having the color turn green. The addition of an amount of lime over 0.35 equivalent in the molecular formula resulted in a green tint.

To satisfy curiosity several trials were made up having the lime added as bone ash. This resulted in a good semi-mat glaze of fine color. The molecular formula is

$$\begin{matrix}0.8\ Na_2O\\0.2\ CaO\end{matrix}\ 0.25\ Al_2O_3\ \begin{matrix}3.75\ SiO_2\\0.066\ P_2O_5\end{matrix}$$

This glaze crazed badly on white earthenware but did not craze on a special high silica body.

IV. Conclusions

The conclusions drawn from this study are (1) that blues of copper can be made at high temperatures by using a high soda glaze containing less than 0.35 equivalent of lime and less than 0.4 equivalent of alumina, and (2) that high silica is favorable to formation of copper blue.

CERAMIC ART DIVISION
FINE ARTS DEPARTMENT, O. S. U.
COLUMBUS, OHIO

AN EXPERIMENT IN EGYPTIAN BLUE GLAZE*

By Charles F. Binns, Myrtle Klem, and Hazel Mott

ABSTRACT

Soft pastes and glazes were developed using soluble fluxes and coloring material which produced results resembling the color and texture effects on Egyptian trinkets.

I. Introduction

The idea upon which this investigation was based was suggested by the examination of a number of Egyptian trinkets and by an inspection of some faience beads made by Miss Henrietta M. Crawford of Bryn Mawr, Pa. These beads had been rolled from a paste and were self-glazed, though the surface was rough and the color was a greenish gray.

Linking this experiment with the Egyptian finger rings the idea took the following form: The fracture of the rings showed a gradual growth of the blue glaze from within to the surface, that is, it looked as if the rings, like Miss Crawford's beads, were self-glazing.

This connected itself with a recollection of the behavior of soluble salts in ceramic manufacture, as in the drier white on brick and the scurf on white ware. This phenomenon is known as "wicking out," because the action is similar to that of oil in a lamp wick.

II. The Investigation

(1) Paste The first step was to produce a workable paste. After a number of experiments the following mixture was found to be satisfactory:

Godfrey feldspar	34.20	Sodium bicarbonate*	5.30
Ground flint	34.20	Copper carbonate	2.60
Georgia clay	10.50	Powdered dextrine	7.90
Sodium carbonate*	5.30		

* The use of the two salts of soda may need explanation. The carbonate was the better in wicking out but the mixture was disposed to harden. Using part as bicarbonate overcame this difficulty.

The soluble salt made it impracticable to use a plaster mold for casting even when coated with varnish. The surface was too rough and was quickly worn out. A carving of an Egyptian bird was then made in plaster and from this an electrotype mold was made. This proved to be satisfactory. The mold was rubbed with cup grease for each impression.

(2) Firing Various heat treatments were tried and ultimately cone 09 in three hours was adopted. The firing was made in a small Hoskins electric muffle.

The blue color of the glaze was known to be due to copper oxide under

* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Art Division).

the influence of soda, but it was evident that both of these substances could not be kept soluble; the copper would precipitate. It was found that copper carbonate,[1] being insoluble in water, would not "wick out" in the body mass, but would glaze on the surface where the soda was concentrated. This effect corresponds closely to that appearing in the fracture of the Egyptian rings.

III. Refinements

Better results were secured by slightly reducing the amount of copper carbonate. The color was enriched by the use of a thin glaze. The first glaze tried was too fluid so that a little clay was used which produced the desired result.

The best glaze was found to be as follows:

Soda ash	35.7	Georgia clay	3.6
Sodium carbonate	35.7	Dextrine	17.9
Copper carbonate	7.1		

This glaze was applied with a brush on the paste while still wet.

IV. Results

The approximation to the Egyptian trinkets is very close in color and structure.

NEW YORK STATE SCHOOL OF CERAMICS
ALFRED, N. Y.

[1] Cuprous chloride is not suitable because of its volatility.

RESULTS OF TEST ON TEN DEMONSTRATIONS OF REINFORCED BRICK STRUCTURES WITH SUMMARY COVERING TESTS ON THIRTEEN STRUCTURES*

By Edward E. Krauss and Judson Voodes

Foreword

Report No. 2 of this series[1] covered tests at Philadelphia, Montreal, and St. Louis, while the present report covers tests on ten additional structures in Philadelphia, Baltimore, and Washington. The structures tested were all built to a given specification by workmen unfamiliar with reinforced brick masonry. A summary of the tests to date is given, not to furnish design data, but to show the facts regarding deficiencies in performance in an effort to formulate some sort of minimum standards.

The general design and location of reinforcement in the demonstration structure is shown in Fig. 1. For further details and specifications see Report No. 1.[1]

Computations in every case are for live load only. Although there is slight difference in the width and depth of slab in some cases, the amount is hardly sufficient to produce much variation in the observation. The recorded unit loads and bending moments have been corrected for this variation and represent the net live loads per square foot and the corresponding bending moments. Deflections were read to one-sixteenth of an inch on each side of each slab or beam and were averaged.

Much work must be done in testing laboratories before the necessary design data can be determined. Lessons may be drawn from these tests for the construction of such members. Most important of these is the fact that mortar materials must be of proper quality and workmanship must be sufficient at least to insure the proper imbedment of the reinforcing. It is hoped that this report will lead to the building and testing of many more such structures, data from every one of which will eventually be of value in formulating design data and standards for workmanship and materials.

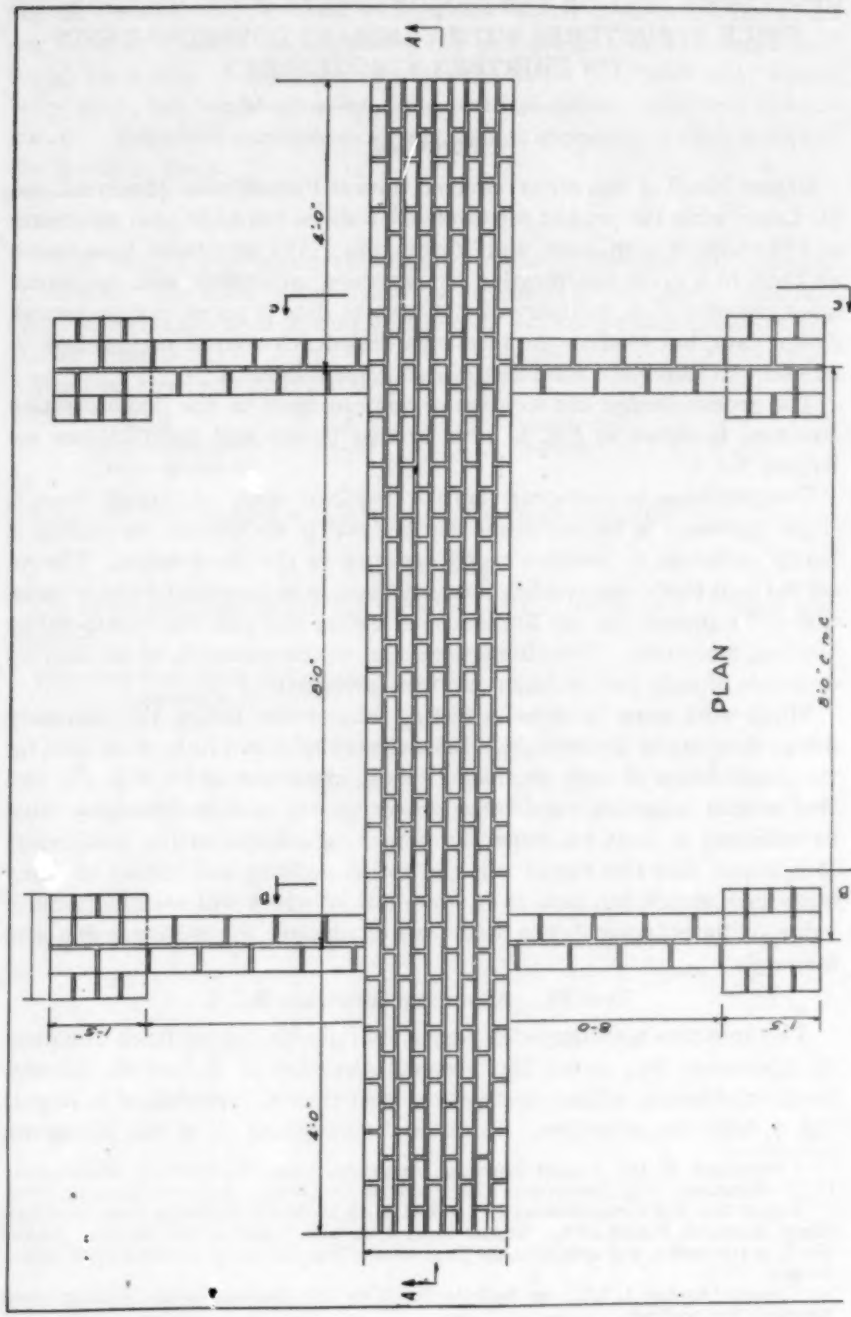
Test IV. Allentown Structure No. 1

This structure was completed June 1, 1931, by the Lehigh Brick Company of Allentown, Pa., under the personal direction of Robert K. Mosser. Local bricklayers, without instruction other than that contained in Report No. 1, built the structure. Brick used throughout all of the Allentown

* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Structural Clay Products Division). Received January, 1932.

Report No. 4 of Committee on Reinforced Brick Masonry, National Brick Manufacturers Research Foundation. Report Nos. 3, 6, and 7 follow this report. Report No. 5, of this series, will appear in the June issue of the *Bulletin of the American Ceramic Society*.

[1] Issued October 1, 1931, as Bulletin No. 2 by the National Brick Manufacturers Research Foundation.


4:0"
8:0"
8:0" c to c
PLAN
4:0"

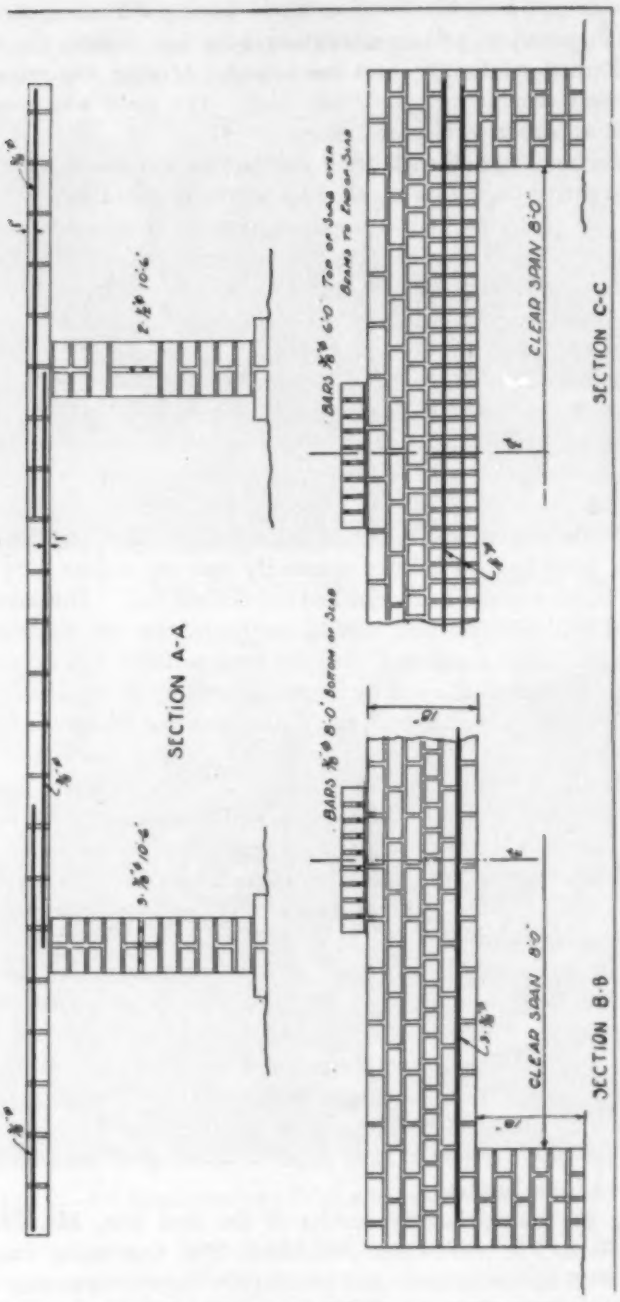


FIG. 1.—Design of reinforced brick masonry demonstration structure.

tests were side-cut, smooth face shale brick, having a crushing strength of about 8000 lb. per sq. in. and an absorption in the 5-hr. boiling test of about 10%. Deformed reinforcing bars were used. Mortar was mixed 1:1:6, using Portland cement and hydrated lime. The sand was commercial mortar sand apparently clean and sharp.

In constructing the slab each brick was laid by the mason with mortar, instead of grouting the joints as called for by the specifications. Upon the removal of the centering, it was apparent that the masonry was unsatisfactory. The mortar, it seems, had not set properly. The consensus of opinion was to the effect that the particular hydrated lime used was not suitable for mortar. Accordingly, the slab was rebuilt using lime putty which performed according to expectations. The beams were not rebuilt.

In loading this slab, after setting for 46 days, the procedure used in the previous tests was followed. Brick were piled in stacks 8 in. by 24 in. with a space between to prevent arching. For every two courses on the center span, one course was placed on the cantilevers thus applying one fourth of the total center load on each of the cantilevers. Loading proceeded until 461 lb. per sq. ft. existed on the center slab. At this point the deflection of the running bond beam increased markedly and was followed by failure. The soldier beam was also badly cracked but did not fail. This latter beam was blocked into position and loading continued for the cantilever slab overhanging it. This continued until the load equaled 278 lb. per sq. ft. when a crack appeared followed by a gradual settling of the load. Inspection of the mortar indicated that there had been considerable slippage of the reinforcing.

Unfortunately, it was not possible to load the main slab after the failure of the running bond beam. The load carried by the one cantilever indicated that the slab was performing as expected. The beams were built with the original mortar, hydrated lime, which had proved unsatisfactory for the slab. No doubt the beams should have been rebuilt at the time of the rebuilding of the slab.

Analysis of the steel stress in the cantilever at failure indicates a unit stress in excess of 20,000 lb. per sq. in. and a unit shearing stress in excess of 30 lb. per sq. in. The beams failed under a relatively small load, 4800 lb. each. This load produced a unit shearing stress of only 20 lb. per sq. in. It was quite apparent that the mortar was not set or bonded to the brick. Few values were obtained from this test but the three following built at the same plant gave very interesting data. Table I gives detailed information obtained from the test.

Following the unsatisfactory results of the first test, Mr. Mosser of Allentown decided to build three structures: The first using lime putty: the second, with hydrated lime; and the third, with cement mortar without lime. Figure 2 shows these three structures ready for test.

Test V. Allentown Structure No. 2

Reinforcing, brick, and mortar were the same as those used in the first Allentown test. Lime in this case was lump (lime putty). The load was

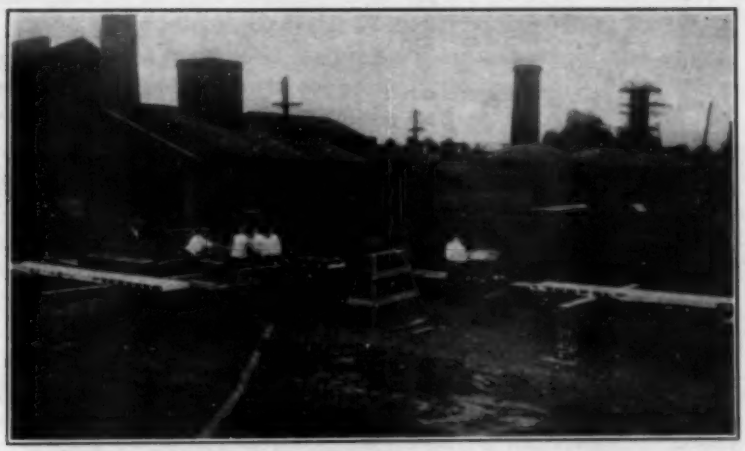


FIG. 2.—Three structures ready for test at Allentown, Pa.

FIG. 3.—Allentown structure No. 2 with load at failure, 434 lb./sq. ft.

applied in the manner used in the previous test. Table II gives detailed results. An inspection of this shows that the center slab reached a deflection of 0.25 in. under a load of about 340 lb. per sq. ft. with an ultimate load

TABLE I

TEST IV. ALLENTOWN STRUCTURE NO. 1

(Beams built May 7; slab, June 1, 1931; tested July 16, 1931)

Loads and Bending Moments								Deflections									
Center span				End span				Slab			Running bond beam			Soldier bond beam			
Layers	Total live load	Unit load	B.M.	Layers	Total live load	Unit load	B.M.	Net	Net	Av.	Net	Net	Av.	Net	Net	Av.	Note
4	1130	76.8	13600	0	0	0.0	0	1.0	1	1	1.5	1	1.25	0.5	1	0.75	
4	1130	76.8	6800	2	282	38.4	6770	0.5	0	0.25	0	1	0.5	−0.1	0.5	0.75	
8	2260	153.6	20400	2	282	38.4	6770	1.5	1	1.25	1	1	1	0.5	1.5	1	
8	2260	153.6	13600	4	564	76.8	13500	1.0	0	0.5	0.5	1	0.75	−0.5	0.5	0.5	
12	3390	231.0	27200	4	564	76.8	13500	1.5	1	1.25	0.1	2	1.5	0	1.5	0.75	
12	3390	231.0	20400	6	846	115.2	20350	1.0	0	0.5	1	1.5	1.25	−0.5	0.5	0.5	
16	4520	308.0	33900	6	846	115.2	20350	1.5	1	1.25	2	2	2	0	1.5	0.75	
16	4520	308.0	27200	8	1128	153.6	27100	1.0	0.5	0.75	1	2	1.5	0.5	0.5	0.5	
20	5650	385.0	40600	8	1128	153.6	27100	2.0	1	1.5	2	2.75	2.4	0	1.5	0.75	
20	5650	385.0	32700	10	1410	192.0	32800	1.0	0	0.5	2	2	2	−0.5	0.5	0.5	
24	6780	461.0	47500	10	1410	192.0	32800	2.0	2	2	3	3.5	3.25	0.5	1.5	1	(A)

(A) Running bond beam failed.

TABLE II

TEST V. ALLENTOWN STRUCTURE NO. 2

(Mortar 1:1:6 lump lime. Beams built July 23; slab, July 27, 1931; tested Sept. 2, 1931)

Loads and Bending Moments								Deflections									
Center span				End span				Slab			Running bond beam			Soldier bond beam			
Layers	Total live load	Unit load	B.M.	Layers	Total live load	Unit load	B.M.	Net	Net	Av.	Net	Net	Av.	Net	Net	Av.	Notes
0	0	0		0	0					0			0			0	
2	632.4	41.6	3800	1	158.1	20.7	3800	0.5	0.5	0.5	0	0	0	0	0	0	
4	1264.8	83.2	7600	2	316.2	41.4	7570	0.8	0.5	0.65	0	0	0	0.2	0	0.1	
6	1897.2	124.8	11400	3	474.3	62.1	11400	1.0	1.0	1.0	0	0	0	0.0	0	0	
8	2529.6	166.4	15200	4	632.4	82.8	15200	1.5	1.25	1.38	0	0	0	0.0	0	0	
10	3162.0	208.0	19000	5	790.5	103.5	19000	2.0	1.5	1.75	0	0	0	0	0	0	
12	3794.4	249.6	23000	6	948.6	123.2	22800	2.5	2.0	2.25	0	0	0	0.2	0	0.1	
14	4426.8	291.2	26400	7	1106.7	143.9	26400	3.0	2.6	2.8	0	0	0	0.25	0	0.13	
16	5059.2	332.8	30400	8	1264.8	164.6	30400	4.0	3.5	3.8	0	0	0	0.25	0	0.13	(A)
18	5691.6	374.4	34200	9	1422.9	185.3	34200	6.0	5.5	5.75	0	0.25	0.13	0.5	0	0.25	
20	6324.0	416.0	38000	10	1581.0	206.0	38000	10.0	9.5	9.75	0.25	0.25	0.25	0.5	0.5	0.5	
20+	6598.0	434.0	39588	11	1739.1	226.7	41500	Center slab failed; sharp break on inner beam face line (52 brick caused failure)									

(A) East cantilever cracked on west face of east beams. West cantilever cracked on face of west beam.

of 434 lb. per sq. ft. Figure 3 shows the structure under load after failure. Under a load of 332 lb. per sq. ft., cracks first appeared across the top of the slab at each support. These gradually widened until failure, which was gradual, occurred. The unit stress in the steel was probably under 20,000 lb. per sq. in. and the shear about 57 lb. per sq. in. Even though this test did not show as great load-carrying ability as some of the others, there seemed to be ample strength for ordinary design loads (light manufacturing). The beams under the maximum load supported about 5000 lb. each, concentrated at the center. This load produced stress in the steel of about 20,000 lb. per sq. in. and shearing stresses of about 20 lb. per sq. in. With

FIG. 4.—Allentown structure No. 3 with load at failure, 452 lb./sq. ft.

this load, the deflection of the beams was well under the allowable. No cracks appeared in either beam.

Although the loads carried by this structure were less than the average, still they were sufficient to indicate possibilities for development. The general breaking up of the slab on failure points to an indication that lime-cement mortar does not combine well with this particular brick.

Test VI. Allentown Structure No. 3

The third of the Allentown series was similar to the second with the exception that hydrated lime was used. The particular brand was different from that used in the Allentown No. 1 test. After standing for 36 days, it was tested September 2, 1931. Brick, mortar, reinforcing, and workmanship were similar to the previous test. Load was applied in the same manner.

Load was applied without any unusual result, producing cracks over the supports at 332 lb. per sq. ft. as in the previous specimen. The load producing the limiting deflection was also 332 lb. per sq. ft. The ultimate load was almost the same as No. 2 structure, 452 lb. per sq. ft. or about 18 lb. per sq. ft. more for this test. The maximum steel stress was about 20,000 lb. per sq. in. and the maximum shearing stress about 60 lb. per sq. in.

Cracks occurred as in previous tests and gradually opened with an increase of load until failure. Figure 4 shows the structure after failure. The beams, although under a load in excess of 5000 lb. concentrated at the center, showed no signs of cracking or deflection. The steel stress for this load was in excess of 20,000 lb. per sq. in.

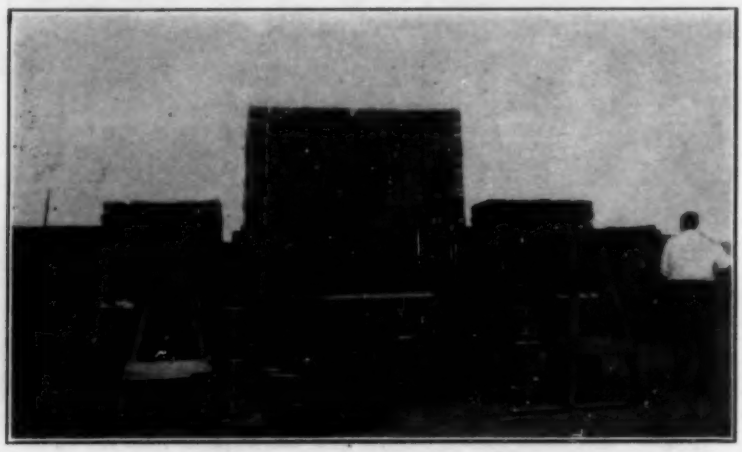


FIG. 5.—Allentown structure No. 4 carrying 624 lb./sq. ft.

This structure in many ways behaved the same as No. 2 (lump lime). The load carried was only slightly greater with apparently greater stiffness in the beams. Failure in the slab was accompanied by a general breaking up of the slab, which might be expected with a failure in the mortar. Few brick were broken except over the supports where the crack extended across the top of the beams.

Test VII. Allentown Structure No. 4

After the apparent lack of success with the first structure at Allentown, Pa., Mr. Mosser decided to build a similar structure using a very rich mortar. After consulting with engineers of a local Portland cement company, a 1:2 mix was selected. This was straight cement mortar with no lime. The factors of brick, reinforcing, and workmanship were the same

TABLE III

TEST VI. ALLENTOWN STRUCTURE No. 3

(Mortar 1:1:6 hydrated lime. Beams built July 22, 1931; slabs, July 28, 1931; tested Sept. 2, 1931)

Loads and Bending Moments								Deflections									
	Center span				End span			Slab			Running bond beam			Soldier bond beam			
Layers	Total live load	Unit load	B.M.	Layers	Total live load	Unit load	B.M.	Net	Net	Av.	Net	Net	Av.	Net	Net	Av.	Note
0	0	0		0	0	0				0			0			0	
2	632.4	41.6	3800	1	158.1	20.7	3800	0.5	0.5	0.5	0	0	0	0	0	0	
Loading cont. at 12:55 P.M.								0.5	0.5	0.5	0	0	0	0	0	0	
4	1264.8	83.2	7600	2	316.2	41.4	7570	0.5	0.75	0.63	0	0	0	0	0	0	
6	1897.2	124.8	11400	3	474.3	62.1	11400	0.75	1.00	0.87	0	0	0	0	0	0	
8	2529.6	166.4	15200	4	632.4	82.8	15200	1.5	1.5	1.5	0	0	0	0	0	0	
10	3162.0	208.0	19000	5	790.5	103.5	19000	2.0	2.0	2.0	0	0	0	0	0	0	
12	3784.4	249.6	23000	6	948.6	123.2	22800	2.5	2.5	2.5	0	0	0	0	0	0	
14	4426.8	291.2	26400	7	1106.7	143.9	26400	3.5	3.0	3.3	0	0	0	0	0	0	
16	5059.2	332.8	30400	8	1264.8	164.6	30400	4.5	4.0	4.25	0	0	0	0	0	0	(A)
18	5691.6	374.4	34200	9	1422.9	185.3	34200	6.0	5.75	5.87	0	0	0	0	0	0	
20	6324.0	416.0	38000	10	1581.0	206.0	38000	8.5	7.5	8.0	0	0	0	0	0	0	
20+	6924.0	452.0	41500	11	1739.1	226.7	41400	Center slab failed at 1:45 P.M.									

(A) Crack across top of east beam in slab on east face line.

as used in the second and third tests. The structure was tested when 37 days old.

Load was applied in the same manner as in the previous cases. No crack appeared in the slab until the load reached 457 lb. per sq. ft. when fine hair cracks appeared in brick and mortar over each support. The limiting deflection was reached under a load of 645 lb. per sq. ft. Loading continued until the total reached 873 lb. per sq. ft. on the center span. A hard rain prevented further work and led to the decision to allow the structure to remain loaded for a period of time.

The deflection was carefully noted and the load allowed to stand 60 days when the structure was loaded to failure. The stress in the steel for this

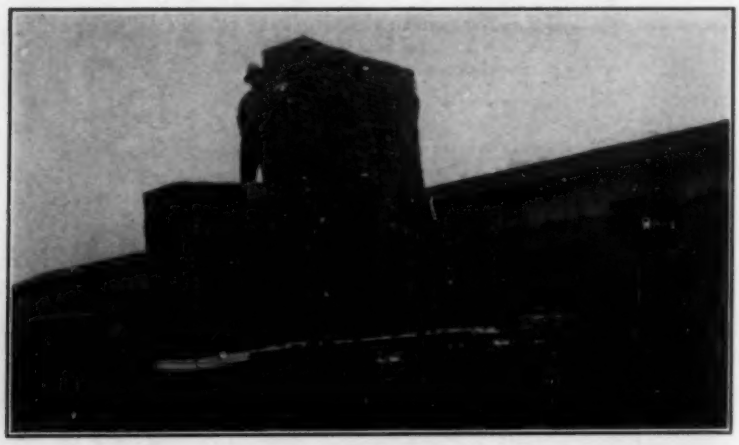


FIG. 6.—Allentown structure No. 4 with 1081 lb./sq. ft. Left cantilever only has failed.

load was about 37,000 lb. per sq. in. After standing under load exposed to the weather for 68 days, no increase in deflection was observed. Figure 5 shows the structure under a load of 624 lb. per sq. ft. during the first part of the test.

Load was applied until failure occurred under 1081 lb. per sq. ft. The cracks which had appeared in the early part of the test continued to widen until failure, which occurred in the left cantilever. The maximum deflection under this load was $^5/_8$ in. Figure 6 shows the structure under maximum load with the right cantilever and center slab still intact. The load was immediately removed, whereupon the center slab recovered $^1/_2$ in. of the $^5/_8$-in. deflection. Table IV gives the detailed data. The beams remained intact throughout the test. No cracks or sign of distress appeared. The load concentrated on the center of each beam amounted to

TABLE IV

TEST VII. ALLENTOWN STRUCTURE NO. 4

(Mortar 1:2 Portland cement. Beams built July 21; slabs, July 27, 1931; tested Sept. 2, 1931)

Loads and Bending Moments								Deflections									
Center span				End span				Slab			Running bond beam			Soldier bond beam			
Layers	Total live load	Unit load	B.M.	Layers	Total live load	Unit load	B.M.	Net	Net	Av.	Net	Net	Av.	Net	Net	Av.	Note
0				0						0			0			0	
2	632.4	41.6	3744	1	158.1	20.7	3790	0.25	0	0.13	0	0	0	0	0	0	
4	1264.8	83.2	7584	2	316.2	41.4	7580	0.50	0.5	0.5	0	0	0	0	0	0	
6	1897.2	124.8	11412	3	474.3	62.1	11400	0.50	0.5	0.5	0	0	0	0	0	0	
8	2529.6	166.4	15200	4	632.4	82.8	15180	0.50	0.75	0.68	0	0	0	0	0	0	
10	3162.0	208.0	19000	5	790.5	103.5	19000	1.0	1.0	1.0	0	0	0	0	0	0	
12	3794.4	249.6	22800	6	948.6	123.2	22800	1.0	1.0	1.0	0	0	0	0	0	0	
14	4426.8	291.2	25500	7	1106.7	143.9	25500	1.25	1.25	1.25	0	0	0	0	0	0	
16	5059.2	332.8	30400	8	1264.8	164.6	30400	1.5	1.5	1.5	0	0	0	0	0	0	
18	5691.6	374.4	34200	9	1422.9	185.3	34200	1.75	1.5	1.63	0	0	0	0	0	0	
20	6324.0	416.0	38000	10	1581.0	206.0	38000	2.0	2.0	2.0	0	0	0	0	0	0	
22	6956.4	457.6	41700	11	1739.1	226.7	41700	2.5	2.5	2.5	0	0	0	0	0	0	(A)
24	7588.8	499.2	45600	12	1897.2	247.4	45600	2.5	2.5	2.5	0.5	0.5	0.5	1.0	0.5	0.75	
26	8221.2	540.8	49600	13	2055.3	268.1	49400	3.0	3.0	3.0	0.5	0.5	0.5	1.0	0.5	0.75	
28	8853.6	582.4	53100	14	2213.4	288.8	53100	3.5	3.5	3.5	0.5	0.5	0.5	1.0	0.5	0.75	
30	9486.0	624.0	56800	15	2371.5	309.5	56900	4.0	4.0	4.0	0.5	0.5	0.5	1.0	0.5	0.75	
32	10118.4	665.6	60800	16	2529.6	330.2	60800	4.5	4.5	4.5	0.5	0.5	0.5	1.0	0.5	0.75	
34	10750.8	707.2	64500	17	2687.7	350.9	64600	5.0	5.0	5.0	0.5	1.0	0.75	1.0	0.5	0.75	
36	11383.2	748.8	68200	18	2845.8	371.6	68300	5.25	5.0	5.13	0.5	1.0	0.75	1.0	0.5	0.75	
38	12015.6	790.4	72096	19	3003.9	391.3	72100	5.5	6.0	5.75	1.0	1.0	1.0	1.0	1.0	1.0	
40	12648.0	832.0	76000	20	3162.0	412.0	76000	6.5	6.0	6.25	1.5	1.0	1.0	1.0	1.0	1.0	
41	13380.4	873.6	Rain stopped loading														
42	12648	832.0	76000	20	3162	412	76000										(B)
43		873.6		21		432.7											
44		915.2		22		453.4											
46		956.8		23		474.1											
48		998.4		24		494.8											
50		1040.0		25		515.5											
52	16440.3	1081.6	98640	26	4110	536.2	Left cantilever failed										

(A) Cracks occurred at cantilever of each beam.

(B) Loading completed Nov. 9, 1931.

TABLE V

TEST VIII. KEYSTONE STRUCTURE

(Mortar 1:1:6 hydrated lime. Beam and slab built July 17; tested Sept. 4, 1931)

Loads and Bending Moments								Deflections									
	Center span			End span				Center slab			Running bond beam			Soldier bond beam			
Layers	Total live load	Unit live load	B.M.	Layers	Total live load	Unit live load	B.M.	Net	Net	Av.	Net	Net	Av.	Net	Net	Av.	Notes
0				0						0			0			0	
2	600	40.8	3600	1	150	20.4	3600	0	0	0	0	0	0	0	0	0	
4	1200	81.6	7200	2	300	40.8	7200	0.25	0.5	0.38	0	0	0	0	0	0	
6	1800	122.4	10800	3	450	61.2	10800	0.5	0.75	0.68	0	0	0	0	0	0	
8	2400	163.2	14400	4	600	81.6	14400	0.75	1.00	0.88	0	0	0	0	0	0	
10	3000	204.0	18000	5	750	102.0	18000	1.00	1.00	1.00	0	0	0	0	0	0	
12	3600	244.8	21600	6	900	122.4	21600	1.00	1.25	1.13	0	0	0	0	0	0	
14	4200	285.6	25200	7	1050	142.8	25200	1.5	1.5	1.5	0	0	0	0	0	0	
16	4800	326.4	28800	8	1200	163.2	28800	1.75	1.75	1.75	0	0	0	0	0.25	0.13	
18	5400	367.2	32400	9	1350	183.6	32400	2.0	2.0	2.0	0.25	0.5	0.37	0.5	0.5	0.5	
20	6000	408.0	36000	10	1500	204.0	36000	2.25	2.0	2.13	0.25	0.5	0.37	0.5	0.5	0.5	
22	6600	448.8	39600	11	1650	224.4	39600	2.50	2.5	2.50	0.25	0.5	0.37	0.5	0.5	0.5	(A)
24	7200	489.6	43200	12	1800	248.8	43200	3.00	3.0	3.0	0.5	0.5	0.5	0.5	0.5	0.5	
26	7800	530.4	46800	13	1950	269.2	46800	3.25	3.25	3.25	0.5	0.5	0.5	0.5	0.5	0.5	
28	8400	571.2	50400	14	2100	289.6	50400	4.00	4.0	4.0	0.5	0.5	0.5	0.75	0.75	0.75	
30	9000	612.0	54000	15	2250	310.0	54000	4.5	4.0	4.25	0.5	0.5	0.5	0.75	1.0	0.88	
32	9600	652.8	57600	16	2400	330.4	57600	5.25	5.0	5.13	0.75	0.75	0.75	1.0	1.25	1.13	
34	10200	693.6	61200	17	2550	350.8	61200	6.0	6.0	6.00	1.25	1.0	1.13	1.5	1.25	1.38	(B)
	10300	700.6	64700	18	2700	371.2	58800	100 lb. additional when slab failed—end loaded									

(A) North side with beam apparent crack slab.
(B) Noticeable cracking center.

12,330 lb. producing steel stresses in excess of 45,000 lb. per sq. in. and shearing stress of 50 lb. per sq. in.

The marked increase in strength in the structure over those built with cement-lime mortar indicates that this particular brick requires a mortar richer than 1:1:6. There are many factors affecting the load-carrying capacity of these structures. It is apparent that the mortar is an important factor. Other structures built with 1:1:6 mortar performed very well. No doubt some mortar richer than the cement-lime mix used and yet not as rich as 1:2 will give ample strength. The load carried was remarkable and beyond the usefulness for such slabs in practical design.

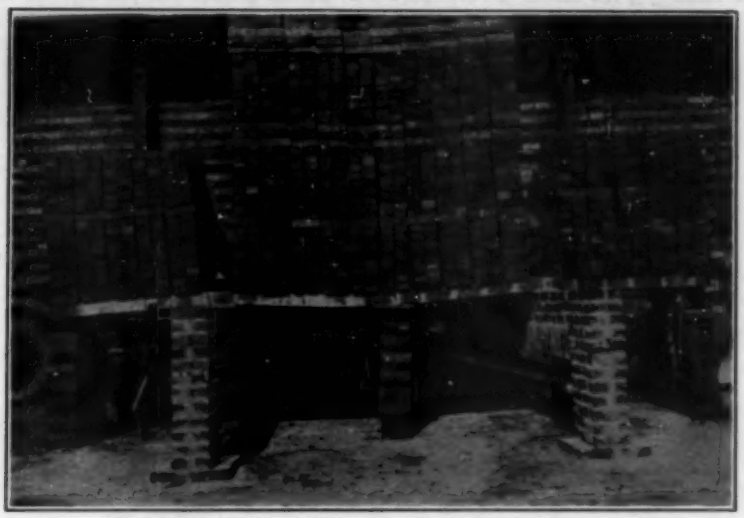


FIG. 7.—Keystone structure with load at failure, 700 lb./sq. ft.

Test VIII. Keystone Structure

This structure was built by the Keystone Brick Company of Philadelphia under the direction of Robert Hamilton and Edward Kelley. The structure was built in one and one-half days by a mason and helper, using straight hard, stiff-mud, end-cut brick. Mortar consisted of 1 part Portland cement, 1 part hydrated lime, and 6 parts sand. Reinforcing bars were commercial, deformed concrete bars. Forms were removed at the end of 10 days at which time the masonry appeared to be sound.

Loading was done in the same manner used for the preceding tests. No sign of failure occurred until the load reached 448 lb. per sq. ft. when transverse cracks first appeared in the top of the slab over the supports. Deflection gradually increased with an increase of load. The limiting

deflection of $^{5}/_{32}$ in. occurred with a live load of 612 lb. per sq. ft. Cracks did not appear on the under side of the slab until a load of 693 lb. per sq. ft. was reached. The maximum live load carried amounted to 700 lb. per sq. ft. on the main span with a deflection of $^{3}/_{8}$ in. Under this load the reinforcing was stressed to about 30,000 lb. per sq. in. Shearing unit stress was about 89 lb. per sq. in. The test was conducted at the age of 48 days. Figure 7 shows the structure under maximum load after failure.

Table V gives the recorded data for the test. An inspection of the loads shows that each beam carried a maximum live load concentrated at the center of 7850 lb. Under this condition of load the deflection was slightly more than $^{1}/_{16}$ in. under a steel stress of about 32,000 lb. per sq. in. and a

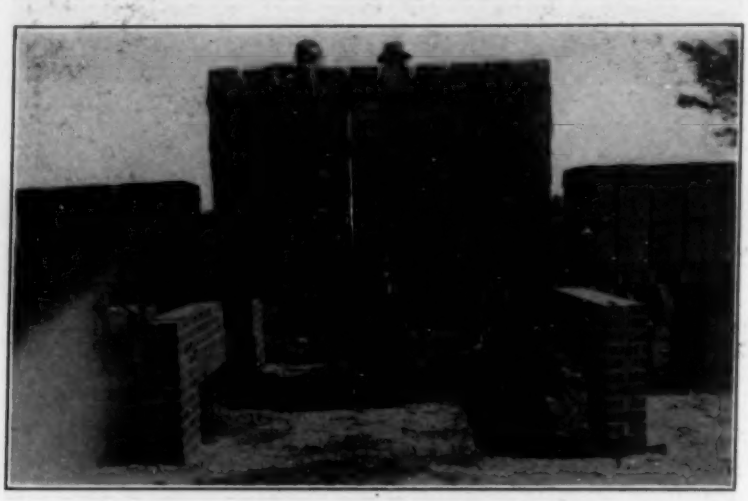


FIG. 8.—Norristown structure with load at failure, 540 lb./sq. ft. Only one cantilever has failed.

shearing stress of about 32 lb. per sq. in. Neither beam was cracked nor showed signs of distress during the test.

Test IX. Norristown Structure

This structure was built at the plant of the Norristown Brick Company at Norristown, Pa., under the personal supervision of William H. Moll. Secretary.

The structure was built in one and one-half days using side-cut stiff-mud, straight hard brick having a compressive strength of about 12,000 lb. per sq. in. and an absorption of less than 8 % on a five-hour boiling test. Reinforcing bars were commercial, deformed concrete bars. Mortar was mixed according to the specification using hydrated lime. On the removal of the forms the masonry was sound with the exception of a longitudinal crack

that extended most of the length of the slab. This was in the first joint and was sufficient to justify the removal of one entire course of brick from the cantilever portion, thus reducing the width of the slab. This cracking was due to warping of the form boards, which was caused by a wetting and by the very hot weather drying the under side quickly.

Load was applied in the manner followed in the previous tests. Figure 8 shows the structure under a load of 540 lb. per sq. ft. Cracks had already appeared under a load of 405 lb. per sq. ft. over the soldier beam. When the load on the center span reached 540 lb. per sq. ft. the north cantilever failed gradually, apparently from some unusual cause since the other cantilever was standing up well.

FIG. 9.—Norristown structure with load at failure of center slab, 697 lb./sq. ft.

It was useless to load this cantilever further but the center span was loaded until failure. During this increase of load, there was little, if any, restraint over one support and no increase in restraint for the other. The second cantilever load remained constant. The moment conditions were not those of a simple span in the center portion, but somewhere between a simple span and those of a fully restrained slab. Under this condition of loading the center slab did not fail until subject to a load of 697 lb. per sq. ft. which is probably equivalent to $^2/_3$ of the total load to be carried where restraint was furnished at the supports. Failure occurred with a steel stress in excess of 29,000 lb. per sq. in. and a shearing stress of about 88 lb. per sq. in. Moment in this case was figured as though the member were fully restrained.

Table VI gives complete data as observed. Figure 9 shows the structure

under maximum load after the center slab had failed. After failure the north cantilever was examined for a possible cause of premature failure. An inspection showed that the top steel had been forced too far down in the mortar joint and, instead of having an average depth of 1 inch, the actual figure was 2.28 in. Thus the steel was in the lower portion of the slab instead of the top. This explained satisfactorily the performance in the test.

The beams each carried a total live load of 5940 lb. concentrated at the center without excessive deflection or sign of cracking. This structure satisfactorily demonstrated the practical uses to which reinforced brick masonry can be placed. Architects and the building inspector who wit-

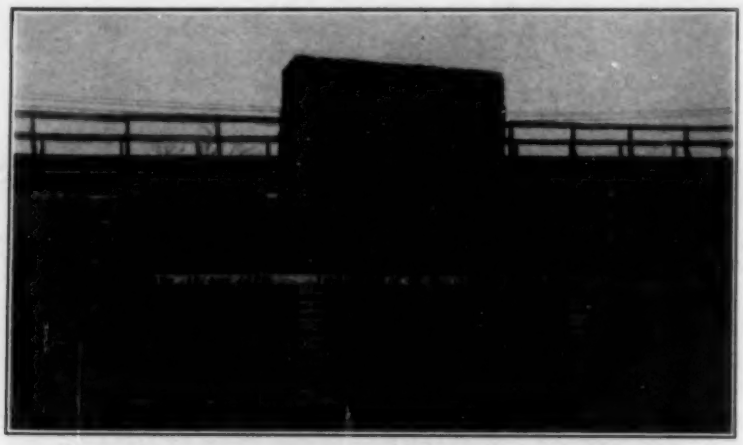


FIG. 10.—Reading structure with 694 lb./sq. ft. before failure.

nessed the test expressed their satisfaction that similar masonry could be used to advantage, particularly in dwelling construction.

Test X. Reading Structure

This structure was built by the Glen-Gery Brick Company of Reading, Pa., at the Wyomissing plant under the personal supervision of Ralph Gery.

The brick used were stiff-mud side-cut straight hard shale brick having a compressive strength of about 6000 lb. per sq. in. and an absorption of about 12% in the five-hour boiling test. Reinforcing consisted of deformed commercial concrete bars. Mortar was mixed according to specification, using hydrated lime.

Load was applied in a manner similar to that used in the previous structures. No sign of failure occurred until the load reached 423 lb. per sq. ft. where transverse cracks appeared over the supports. At a load of 538 lb.

TABLE VI

TEST IX. NORRISTOWN STRUCTURE

(Mortar 1:1:6 hydrated lime. Beam and slab built July 28, 1931; tested Sept. 8, 1931; age, 42 days)

Loads and Bending Moments								Deflections									
	Center span			End span				Center slab			Running bond beam			Soldier bond beam			
Layers	Total live load	Unit live load	B.M.	Layers	Total live load	Unit live load	B.M.	Net	Net	Av.	Net	Net	Av.	Net	Net	Av.	Notes
0				0						0			0			0	
2	660	45	3960	1	165	22.5	3960	0	0	0	0	0	0	0	0	0	
4	1320	90	7920	2	330	45.0	7920	0	0	0	0	0	0	0	0	0	
6	1980	135	11880	3	495	67.5	11880	0.25	0.5	0.38	0	0	0	0	0	0	
8	2640	180	15840	4	660	90.0	15840	0.5	0.5	0.5	0	0	0	0.25	0	0.13	
10	3300	225	19800	5	825	112.5	19800	0.5	0.5	0.5	0	0	0	0.5	0	0.25	
12	3960	270	23760	6	990	135.0	23760	0.5	1.0	0.75	0	0	0	0.5	0	0.25	
14	4620	315	27720	7	1155	157.5	27720	0.75	1.5	1.13	0	0	0	0.5	0	0.25	
16	5280	360	31680	8	1320	180.0	31680	1.75	1.5	1.68	0.5	0	0.25	0.75	0.5	0.68	
18	5940	405	35640	9	1485	202.5	35640	2.0	1.75	1.87	0.5	0	0.25	0.75	0.5	0.68	(A)
20	6600	450	39600	10	1650	225.0	39600	2.5	2.5	2.5	0.5	0	0.25	1.0	0.5	0.75	
22	7260	495	43560	11	1815	247.5	43560	2.75	3.5	3.13	0.5	0	0.25	1.0	0.5	0.75	
24	7920	540	47520	12	1980	270.0	47520	3.5	4.25	3.88	0.5	0.5	0.5	1.0	0.5	0.75	(B)
24	7920	540		16		360											
26	8580	585		Center slab loaded only				6.5	8.5	7.5							
27	8910	607.5						7.5	8.5	8.0							
28	9240	630.0						8.25	9.5	8.88							
29	9570	652.5						9.5	10.5	10.0							
30	9900	675.0						11.0	12.5	11.75							
31	10230	697.5						Failed at this loading									

(A) First crack on north end span through brick and mortar on line of north face of soldier beam.
(B) North cantilever failed at center of beam (soldier) steel found to average 2.28 below surface of slab; no slipping found.

TABLE VII

TEST X. READING (PA.) STRUCTURE

(Mortar 1:1:6 hydrated lime. Built July 30, 1931; tested, Nov. 25, 1931; age 118 days)

Loads and Bending Moments								Deflections									
Center span				End span				Center slab			Running bond beam			Soldier bond beam			
Layers	Total live load	Unit live load	B.M.	Layers	Total live load	Unit live load	B.M.	Net	Net	Av.	Net	Net	Av.	Net	Net	Av.	Notes
0				0						0			0			0	
4	1300	77	7200	2	300	38	7200	0	0	0	0	0	0	0	0	0	
8	2400	154	14400	4	600	77	14400	1	1	1	0	0	0	0	0	0	
12	3600	231	21600	6	900	115	21600	1	1	1	0	0	0	0	0	0	
14	4200	269	25200	7	1050	135	25200	1	1	1	0	0	0	0	0	0	
16	4800	307	28800	8	1200	154	28800	1.5	1.5	1.5	0	0	0	0	0	0	
18	5400	346	32400	9	1350	173	32400	1.5	1.5	1.5	0	0	0	0	0	0	
20	6000	385	36000	10	1500	192	36000	2	2	2	0	0	0	0	0	0	
22	6600	423	39600	11	1650	212	39600	2	2	2	0	0	0	0	0	0	(A)
24	7200	461	43200	12	1800	231	43200	2.25	2.25	2.25	0	0	0	0	0	0	
26	7800	500	46800	13	1950	250	46800	3	3	3	0.5	0	0.25	0.25	0	0	
28	8400	538	50400	14	2100	279	50400	3	3	3	0.5	0	0.25	0.5	0.25	0.38	(B)
30	9000	576	54000	15	2250	288	54000	4	4	4	0.5	0	0.25	1	0.5	0.75	
32	9600	615	57600	16	2400	308	57600	4.5	4.5	4.5	0.5	0	0.25	1	0.5	0.75	
34	10200	655	61200	17	2550	327	61200	5.5	5.5	5.5	1	0	0.5	1	0.5	0.75	
36	10800	694	64800	18	2700	346	64800	7	7	7	1	0	0.5	1	1	1	
38	11400	730	68400	19	2850	366	Running bond only										
				18	2700	346	Soldier bond beam										

(A) Cracks first appeared over supports.
(B) Crack appeared in bottom of center span.

per sq. ft., a transverse crack appeared in the center of the main span. It was not until the load reached about 600 lb. per sq. ft. that the deflection amounted to the allowable. Just before failure, under a load of 730 lb. per sq. ft., the deflection of the center span was $^9/_{16}$ in. Under this load the center slab gradually settled down on the piers provided, followed by a settling of the cantilevers.

The maximum steel stress was about 32,000 lb. per sq. in. with a corresponding shear of about 86 lb. per sq. in.

Each beam was loaded with 8400 lb. live load at the center with very little deflection and no sign of cracks. Table VII gives the complete data as observed during the test. Figure 10 shows the structure under a load of 694 lb. per sq. in. before failure. Transverse cracks occurred over the supports and in the bottom of the center span indicating that the masonry was overstressed at these points and that the tensile stresses were all taken by the reinforcing. These cracks were straight through brick and mortar.

Test XI. Washington Structure No. 1

This structure is one of the two built at West Brothers Brick Company at Washington, D. C.

The brick used were semi-dry press having a compressive strength of about 4200 lb. per sq. in. and an absorption of about 12%. Mortar was mixed according to specification, using hydrated lime. Reinforcing consisted of commercial, deformed concrete bars. The structure was tested at the age of 34 days.

Load was applied in a manner similar to that used in previous tests. The first sign of failure occurred with a load of 560 lb. per sq. ft. when a hair crack appeared over one support. A similar hair crack occurred over the other support with a load of 640 lb. per sq. ft. The limiting deflection was just about reached at the same load. This load was allowed to remain on the structure.

Under the maximum load the beams showed signs of cracking in the bottom near the center of the span.

This test was concluded for the time, with the thought of testing the structure to failure at a later date. The maximum steel stress for the load was about 26,000 lb. per sq. in. and the unit shear about 75 lb. per sq. in. Table VIII gives complete data for this test.

Although this structure showed signs of cracking, still it demonstrated considerable load-carrying ability. Inasmuch as the beams apparently were showing signs of distress under small loads, the test was not continued further. Later inspection will no doubt give valuable information on the behavior of such a structure under continued loading.

Test XII. Washington Structure No. 2

This structure was also built at West Brothers Brick Company at

TABLE VIII

TEST XI. WASHINGTON STRUCTURE NO. 1

(Mortar 1:1:6 hydrated lime. Built Oct. 29, 1931; tested Dec. 2, 1931; age, 34 days)

Loads and Bending Moments								Deflections (Inches)									
	Center span				End span			Center slab			Running bond beam			Soldier bond beam			
Layers	Total live load	Unit live load	B.M.	Layers	Total live load	Unit live load	B.M.	Net	Net	Av.	Net	Net	Av.	Net	Net	Av.	Notes
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	1210	80	7260	2	336	42	7260	0	0.020	0.010	0	0	0	0	0	0	
8	2419	160	14514	4	672	84	14514	0.063	0.090	0.077	0	0.025	0.013	0.010	0.025	0.017	
12	3629	240	21774	6	1008	126	21774	0.079	0.090	0.084	0.025	0.035	0.030	0.025	0.035	0.030	
16	4838	320	29028	8	1344	168	29028	0.116	0.120	0.118	0.038	0.035	0.036	0.050	0.050	0.050	
20	6048	400	36288	10	1680	210	36288	0.136	0.140	0.138	0.050	0.050	0.050	0.060	0.075	0.067	
24	7258	480	43548	12	2016	252	43548	0.171	0.170	0.171	0.050	0.050	0.050	0.075	0.075	0.075	
28	8470	560	50820	14	2352	294	50820	0.179	0.205	0.192	0.060	0.075	0.068	0.100	0.125	0.113	(A)
32	9677	640	58062	16	2688	336	58062	0.189	0.240	0.214	0.100	0.085	0.092	0.150	0.150	0.150	(B)
	Structure stood overnight																
32	9677	640	58062	16	2688	336	58062	0.252	0.265	0.258	0.100	0.085	0.092	0.150	0.175	0.163	(C)
	Actual B.M., 55800 in.-lb.																

(A) Hair crack in slab top straight across in line with longitudinal center of running bond beam.
(B) Similar hair crack over soldier beam.
(C) Soldier beam shows cracks in mortar joint at top of piers due to lifting. Also two cracks in mortar joints near center of span and in soldier courses, all at bottom.

Washington, D. C. Brick used were the same as in test No. XI as well as reinforcing, mortar, and workmanship.

After standing for 34 days, the structure was loaded in the same manner as in the previous structures. Under a load of 400 lb. per sq. ft. the soldier beam failed under a load at center of 4704 lb. This beam was jacked up and used as a fixed support for the slab during the remainder of the test. Cracks occurred over the supports with loads of 560 and 640 lb. per sq. ft. The running bond beam failed under a load of 880 lb. per sq. ft. or a concentrated load of 8460 lb. This beam was also jacked up and loading of the slab continued. One cantilever failed when the load reached 960 lb. per sq. ft. on the center slab and the other, together with the center slab, failed

FIG. 11.—Washington structure No. 2 with load at failure, 1073 lb./sq. ft.

with a corresponding load of 1073 lb. per sq. ft. Table IX gives the data for this test.

An inspection of the beams after failure showed that the mortar hardly covered the reinforcing and there was much apparent slippage. The slabs stood up very well. Figure 11 shows the structure under final load. The maximum stress in the steel was about 45,000 lb. per sq. in. and the shearing stress about 125 lb. per sq. in. This structure, the slab, carried more load than any of those preceding built with cement-lime mortar.

Test XIII. Baltimore Structure

This structure was built by the Baltimore Brick Co., Baltimore, Md. After standing for 50 days the structure was tested before a group of 120 engineers and architects from the city of Baltimore.

TABLE IX

TEST XII. WASHINGTON STRUCTURE NO. 2

(Mortar 1:1:6 hydrated lime. Built October 30, 1931; tested Dec. 3, 1931; age, 34 days)

Loads and Bending Moments								Deflections (Inches)									
	Center span				End span			Center slab			Running bond beam			Soldier bond beam			
Layers	Total live load	Unit live load	B.M.	Layers	Total live load	Unit live load	B.M.	Net	Net	Av.	Net	Net	Av.	Net	Net	Av.	Notes
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	1210	80	7260	2	336	42	7260	0.025	0	0.013	0	0.010	0.005	0	0	0	
8	2420	160	14520	4	672	84	14520	0.050	0.035	0.042	0	0.025	0.013	0.025	0	0.013	
12	3630	240	01780	6	1008	126	21780	0.075	0.050	0.062	0	0.025	0.013	0.025	0.025	0.025	
16	4840	320	29040	8	1344	168	29040	0.100	0.075	0.088	0.010	0.035	0.023	0.050	0.030	0.044	
20	6048	400	36288	10	1680	210	36288	0.110	0.100	0.105	0.040	0.050	0.045	0.150	0.150	0.150	(A)
24	7260	480	43560	12	2016	252	43560	0.150	0.175	0.163							
28	8470	560	50820	14	2352	294	50820	0.160	0.200	0.180							(B)
32	9680	640	58080	16	2688	336	58080	0.175	0.225	0.200							(C)
36	10890	720	65340	18	3024	378	65340	0.225	0.250	0.238							(D)
40	12096	800	72576	20	3360	420	72576	0.250	0.300	0.275							
44	13310	880	79860	22	3696	462	79860	0.275	0.325	0.300							(E)
44	13310	880	79860	22	3696	462	79860	0.275	0.375	0.325							(F)
48	14520	960	87120	24	4032	504	87120	0.475	0.525	0.500							(G)
50	15125	1000	90750	25	4200	525	90750	0.525	0.600	0.563							
52	15730	1040	94380	26	4368	546	94380	0.675	0.675	0.650							
54	16206	1073	97236	27	4435	554	97236				Actual B.M., 95,500 in.-lb.						(H)

(A) Soldier beam failed. Load at center, 4704 lb. total. This beam was jacked up to bring slab level and test proceeded.
(B) Hair crack in top of slab over running bond beam.
(C) Hair crack in top of slab over soldier beam.
(D) Cracks appeared in running bond beam indicating approaching failure in shear. Load at center of beam, 8460 lb.
(E) Running bond beam failed in shear.
(F) Readings on slab after failed beam was jacked up to level slab.
(G) Cantilever slab failed over running bond beam.
(H) Other cantilever and center slab failed. The 54 courses load were short over beams and bottom at center. Load piled 10 ft. 5 in. high.

Load was applied in the same manner used in the previous tests. Brick used for this structure were straight hard side-cut stiff-mud brick with a compressive strength of about 5000 lb. per sq. in. Mortar was mixed according to specification, using hydrated lime and bank sand. A test of the sand showed about 25% clay which probably explained the condition of the mortar. While drilling holes for the testing apparatus it was apparent that the mortar was not set. Under a load of 306 lb. per sq. ft., cracks appeared in the top of the slab over each support. The limiting deflection was reached at a load of 442 lb. per sq. ft., at which time the entire structure gradually settled on the temporary piers. Table X gives the data for this test. Figure 12 shows the structure after failure giving an

FIG. 12.—Baltimore structure with load at failure, 442 lb./sq. ft.

idea of the maximum load carried. Under the maximum load the stress in the steel was about 22,400 lb. per sq. in. From the test it was apparent that the mortar failed throughout the structure. On failure there was a general breaking up of the slab through the joints. Too much emphasis cannot be placed on the desirability of using clean, sharp sand, such as is suitable for concrete. Although this structure carried considerable load, it was apparent that stronger mortar would have increased the load-carrying capacity.

Analysis of Tests on Thirteen Structures

To date thirteen structures have been built and tested, of which two were constructed using cement mortar, not in accordance with the specifications. These were the Philadelphia and the Allentown No. 4 structures.

TABLE X

TEST XIII. BALTIMORE STRUCTURE

(Mortar 1:1:6 hydrated lime. Beam built Oct. 26, 1931; tested Dec. 15, 1931; age, 50 days)

Loads and Bending Moments								Deflections									
Center span				End span				Center Slab			Running bond beam			Soldier bond beam			
Layers	Total live load	Unit live load	B.M.	Layers	Total live load	Unit live load	B.M.	Net	Net	Av.	Net	Net	Av.	Net	Net	Av.	Notes
0																	
4	1114.6	68	6687	2	278	33.6	6687	0.5	0.5	0.5							
8	2229.2	136	13375	4	556	67.2	13375	1.0	0.5	0.5	0.5						
10	2786.5	170	16719	5	695	84.0	16719	1.0	0.5	0.75	0.5		0.5			0.5	
12	3343.8	204	20062	6	834	100.8	20062	1.0	0.5	0.75	0.5		0.5			0.5	
14	3901.1	238	23406	7	973	117.6	23406	1.0	1	1.0	0.5		0.5	0.5	0.5	0.5	
16	4458.4	272	26550	8	1112	134.4	26550	1.5	1	1.25	0.5		0.5	0.5	0.5	0.5	
18	5015.7	306	30094	9	1251	151.2	30094	2.0	1.5	1.75	0.5	0.5	0.5	0.75	0.5	0.75	(A)
20	5573.0	340	33438	10	1390	168.0	33438	2.5	2.0	2.25	0.5	0.5	0.5	1.0	1	1.0	
22	6130.3	374	36782	11	1529	124.8	36782	3.5	3.0	3.25	1	0.5	0.75	1.0	1	1.0	
24	6687.6	408	40125	12	1668	201.6	40125	5.0	4.0	4.5	1	1	1.0	1.5	1	1.25	
26	7244.9	442	43470	13	1807	218.4	43470	Failed center and end at same time									

(A) Crack appeared in top of slab over support.

All of the others were built entirely according to the specifications given in Report No. 1.

Slabs

Table XI gives a summary of results of the tests covering the slabs only. Computed values of the shearing stress, compressive stress in the masonry, stress in the steel, and bond stress are given. These are based on assumed

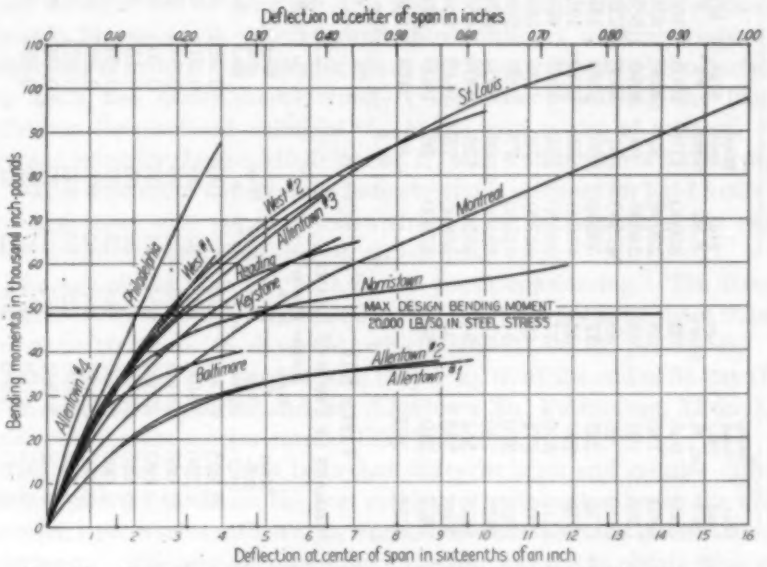


FIG. 13.—Demonstration structure. Bending moment-deflection diagram.

Center span 8 ft. center to center of beam supports. Width, 24 in. Total depth, $3^3/_4$ in. Reinforcing: $8^3/_8$-in. ϕ rods $2^3/_4$ in. center on center. Effective depth $2^3/_4$ in. *Note:* Allentown structure No. 4 in diagram should be No. 1; No. 1 should be No. 2; No. 2 should be No. 3; and No. 3 should be No. 4.

value of the depth of the neutral axis of 0.38 of the depth to steel and 0.88 of the depth to the steel for the value of the distance from center of steel to centroid of compression.

Figure 13 is a chart showing the relation between maximum bending moment at the center of the 8-ft. slab and the deflection at that point. Averages are given for each factor in the table including the two cement mortar structures. It is interesting to note that the average maximum load for all of these structures is well above the usual design load of 125 lb. per sq. ft. used for ordinary commercial occupancies. The average load at failure was 705 lb. per sq. ft. With the exception of three tests at Allentown and the one at Baltimore, where some conditions produced mortar

TABLE XI

SUMMARY OF TESTS OF SLABS

Location	Center Slab			End Slabs			Center Slabs						
	Max. load (lb.)	Max. load (lb./sq. ft.)	Max. def. (in.)	Max. load (lb.)	Max. load (lb./sq. ft.)	Age (days)	Max. B.M.	Max. unit shear	Max. F_b	Max. F_s	Max. bond stress	Unit load first crack	Unit load def. = 0.26 in.
Philadelphia	14620	995	0.219	7300	995	102	85000	110	2800	40000	320	350	Failed
Montreal	12120	825	1.203	1364	186	38	122096	92	4030	57000	267	413	332
St. Louis	12300	837	0.766	1395	191	48	124000	93	4090	58300	270	608	456
Allentown No. 1	6780	461	0.125	1410	96	46	47500	51	1500	22300	149		Failed
Allentown No. 2	6598	434	0.615	1739	227	37	39590	50	1250	18500	145	332	340
Allentown No. 3	6924	452	0.500	1739	227	36	41500	53	1310	19500	153	332	333
Allentown No. 4	16440	1082		4110	536	37	98640	124	3060	46300	361	457	645
Keystone	10300	700	0.375	2700	371	48	64700	78	2135	30400	226	448	612
Norristown	10230	698	0.734	1980	270	41	61380	77	2020	28800	251	405	540
Reading	11400	730	0.438	2850	366	118	68400	86	2000	32100	229	423	596
Washington No. 1	16206	1073	0.650	4435	554	34	95500	125	2800	45000	358	560	720
Washington No. 2	9677	640	0.260	2688	336	34	55800	75	1640	26400	214	560	640
Baltimore	7245	442	0.280	1807	219	50	47500	56	1400	22400	160	306	408
Average	10834	721		2732	352			82	2310	34300	239	433	511

TABLE XII

SUMMARY OF TESTS OF BEAMS

Location		Max. load (lb.)	Max. bending moment (in.-lb.)	Max. shear (lb.)	Soldier Beams					Running Bond Beams				
					Max. defl. (in.)	Max. F_s (lb./sq. in.)	Max. F_b (lb./sq. in.)	Max. v	Max. u	Max. defl. (in.)	Max. F_s (lb./sq. in.)	Max. F_b (lb./sq. in.)	Max. v	Max. u
Philadelphia		14610	306810	7305	0.095	64000	1170	65	190	0.063	68300	953	59	152
Montreal		7424	155904	3712	0.250	32400	592	33	96	0.219	34600	482	30	77
St. Louis		7545	158445	3773	0.063	33000	605	33	98	0.032	35200	492	30	78
Allentown No. 1		4800	100800	2400	0.063	22500	384	21	62	0.203	24000	313	19	50
Allentown No. 2		5038	105738	2519	0.003	22000	403	22	65	0.156	23400	329	20	53
Allentown No. 3		5201	109401	2600	0.000	22800	418	23	67	0.000	24400	341	21	54
Allentown No. 4		12330	258930	6165	0.000	54000	985	55	160	0.000	57500	804	50	129
Keystone		7850	164850	3925	0.086	34300	628	35	102	0.071	36500	512	32	82
Norristown		5940	124740	2970	0.032	26000	475	26	77	0.047	27800	388	24	62
Reading		8400	176400	4200	0.063	36700	673	37	109	0.032	39200	550	34	88
Washington No. 1	{	4704	96500	2352	0.15	19500	369	21	61	...	...	...	..	...
	{	10351	217000	5176	...	...	..	..	...	...	48800	675	42	108
Washington No. 2		7527	158000	3764	0.163	31800	603	34	96	0.093	35400	492	31	78
Baltimore		5432	114000	2716	0.078	23000	435	25	70	0.063	25400	335	23	57

apparently deficient in strength, the average represents a fair value for the cement-lime mortar structures. There was a factor of safety of at least $2^1/_2$ in every case considering a load of 125 lb. per sq. ft. live load. In no case was there any sign of crushing in the brickwork. Apparently high strengths depend on suitable mortars. In some cases the steel was stressed up to the yield point and no slab failed at a shearing stress under 50 lb. per sq. in.

The load at which cracks first appeared is of interest. The average for these values is 430 lb. per sq. ft. live load. The minimum load in this case was 306 lb. per sq. ft. which is well above ordinary working loads. The possibility of using a 4-in. slab for spans of 8 ft. in any but light manufacturing loads and under seems remote. The load producing the limiting deflection for plastered ceiling of $^1/_{360}$ of the span is also of interest. The average value for these is 545 lb. per sq. ft. with a minimum of 332 lb. per sq. ft. This minimum and average indicate ample stiffness for light loads. If the structures with apparent extra strength or deficiencies of the mortar are eliminated, the values do not vary much.

The age of the structure is a factor worth considering. The Reading structure, 118 days old, carried 730 lb. per sq. ft.—very little more than the Keystone structure 48 days old, which carried 700 lb. per sq. ft. The Washington No. 2 test carried 1073 lb. per sq. ft. at the end of 34 days built with cement-lime mortar and the Allentown No. 4 structure, 37 days old, built with cement mortar carried 1082 lb. per sq. ft.

It is apparent from these tests that different brick will require different kinds of mortar to obtain the best results. On the other hand, the mortar specified gave results sufficient to warrant the use of similar construction for light loads. The original intention of the test was not to obtain laboratory data but rather to stimulate interest; therefore the figures given should not be analyzed in too much detail. There are many variables which affect the results and the data published are to be used for comparative study only.

The chart showing deflection gives a splendid picture of the stiffness of the structures. Except for the two Allentown structures, which had low strength and stiffness, the values for the other slabs fall within a fair range of the average. The maximum design bending moment shown is based on a value of j equal to 1. Thus 48,500 in.-lb. would be the maximum design bending moment.

Beams

Table XII gives the values obtained in testing 26 beams. The averages have not been set up inasmuch as only a few of the beams were tested to failure. Two beams in the Allentown Structure No. 1 and two in the Washington Structure No. 1 actually failed. Those in the Washington Structure No. 2 showed signs of cracking but did not actually fail. The

remaining 20 beams all stood up under considerable load. Total load was governed by the strength of the slab. Both the Philadelphia and Allentown No. 4 structures were built with cement mortar and carried loads of 14,610 and 12,330 lb., respectively. The beams listed above which failed during test all carried loads in excess of the requirements for ordinary lintels.

The remaining 18 beams were all built according to the standard specification as set forth in Report No. 1. These beams carried loads ranging from 5038 to 8400 lb. with an average close to 7000 lb. The deflection with these loads in no case exceeded the allowable for plastered ceilings. Values are given for the various unit stresses based on arbitrary assumptions which are for comparison only. Since all of the beams were built according to one specification such a comparison is possible even though the computed stresses are not theoretically correct. In most cases, the steel stresses are below the elastic limit indicating that there is an excess of steel for ordinary lintel loads. Considering that the masonry stresses average above the ordinary working stresses for cement-lime mortar masonry the tests generally indicate that such beams are practical for lintel construction even where concentrated loads occur. An 8-ft. lintel in an 8-in. wall would have to support a portion of wall equivalent to a live load of 1200 lb. uniformly distributed. This is equivalent to a load of 600 lb. concentrated at the center. The loads carried by these beams indicate that fairly large floor loads can also be provided for in such simple designs.

METHOD OF TESTING REINFORCED BRICK MASONRY DEMONSTRATION STRUCTURES*

By Edward E. Krauss and Judson Vogdes

I. Introduction

The Committee in its Report No. 1 presented details of the design and of the building of the reinforced brick masonry demonstration structure, and the results of testing three such structures are given in Report No. 2.[1] The present report covers the methods used in testing demonstration structures in various parts of the country, and has been prepared to give instructions to those making tests so that the results obtained may be accurately compared with the tests of other such structures. It is suggested that this report be carefully studied before starting a test so as to become thoroughly familiar with the various operations necessary to secure as accurate data as possible. Where an engineer is not available

* Report No. 3 of Committee on Reinforced Brick Masonry.

[1] See footnote 1, p. 273.

to supervise the test, the instructions given herein must be carried out exactly to avoid difficulties and to obtain the desired information. The presence of an engineer familiar with reinforced brick masonry is recommended where possible.[2]

II. Object of Test

The object of the test is to demonstrate to the engineer, architect, and brick manufacturer, the load-carrying capacity of reinforced brick masonry structures built to a given design and specifications in various parts of the country, using various local materials and by masons of varying skill. The tests do not represent laboratory work but show actual field construction, and the results should develop general confidence in such construction.

III. Age of Structure at Test

The structure should be at least 30 days old when subjected to test. In case of freezing weather care should be taken that the mortar has had 30 days in which to set, *i.e.*, if the mortar is laid in freezing weather it should have at least 24 hours during which the initial set can take place before the mortar freezes. It is best to allow 45 days under such conditions before making the test.

IV. General Method of Testing

In this test a record should be made of the load applied and the corresponding deflections produced in the slab and each of the two beams. The load is applied by placing dry brick on the slab and the deflections for each increment of load obtained by reading on paper scales at the center of the beam or slab the position of wires stretched between the points of support. Careful notes should be made of the appearance of cracks and the proper photographs taken to record both the loads at the time and the cracks themselves.

V. Apparatus Required for Test

Practically all the equipment necessary can be obtained from the local hardware store, 5 and 10 cent store, and stationery store. The material is as follows:

(*a*) One spool of No. 28 wire, about 60 ft.

(*b*) Six small coil springs about 3 in. long and not more than $^1/_4$-in. in diameter, made by cutting a long coil spring such as is generally sold

[2] In case there is any question in the minds of those proposing to conduct such a test as to the correct procedure, address the Secretary of the Committee at 334 South Nineteenth Street, Philadelphia, Pa.

for screen doors or curtains. Make a loop at each end of each spring for fastening the wire.

(*c*) Twelve expansion sleeves with flat head screws about $1\frac{1}{4}$ in. long, and a star drill to fit the sleeve. These are used to hold the ends of the wires.

(*d*) A small cheap mirror, about 4 by 6 in. Cut this up into 6 pieces about $\frac{1}{2}$ by 2 in., with an ordinary glass cutter.

(*e*) Six small scales of paper graduated to $\frac{1}{16}$ inch, cut from paper scales as used by school children or from cross-section paper into strips about $\frac{1}{4}$ in. wide and 2 in. long.

(*f*) Twelve strips of thin flannel or similar goods, cut to the same size as the mirrors and scales.

(*g*) One small bottle of LePage's glue or equivalent.

(*h*) One piece of chalk or soapstone to mark the appearance of cracks and to number the layers of brick load.

VI. Method of Obtaining and Reading Deflections

(a) In order to apply the above equipment to the slab and beams, proceed as follows: Lay off the center of slab and each beam between supports. Also lay off on each side of both beams and the slab the position of the holes for the screws holding the wires. These locations are all indicated in Fig. 1. There are 12 holes to be located as indicated by the arrows in Fig. 1. Now make holes in each position with the star drill, sufficiently deep that the sleeves will be flush, and put in the screws so that the wires will clear the structure about $\frac{1}{4}$ in. It will be noted that the holes in the slab are in the center of the slab vertically and directly over the center of the supporting beams. The holes in the beams are right over the inside edge of the piers and in the center of the third course of brick from the top.

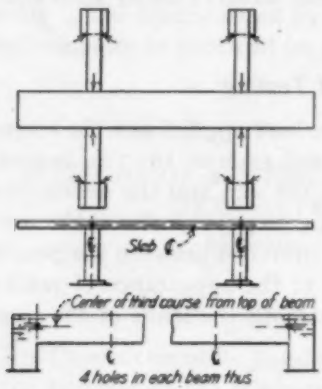


FIG. 1.—Location of expansion screws for holding deflection wires.

Fasten one end of the wire to one of the screws and the other end to one of the small coil springs which has been previously hooked on to the other screw. Be sure to have sufficient tension in the spring to remove all sag from the wire. Now proceed the same with the other sets of screws so that there will be a wire on each side of each beam and of the slab, making six wires in all.

On the center line of each beam and slab, directly under the wire, proceed to glue one piece of felt to the brickwork to which one of the scales is glued. Right alongside of this, glue another piece of felt and on

it one of the small mirrors. In the case of the slab, the bottom of the scale and mirror should be about $^1/_4$ in. below the wire. In the case of the beams, the scales and mirrors should be centered on the wire. The top of Fig. 3 shows the details.

(b) Procedure in Reading Deflections To read the deflections place the eye on a level with the wire, so the reflection of the wire can be seen in the mirror. Now move the eye up or down until the reflection of the wire is behind the wire itself. At the same time note where the wire appears on the scale. Readings are usually taken in sixteenths. The bottom of the graduated scale is considered as zero. As the structure is loaded and deflects, the mirrors and scales are lowered while the wire remains stationary. The reflection and the wire must be in line for each reading. Care must be taken throughout the test that the wires are not disturbed. Before any load is applied a reading must be taken on each scale and noted.

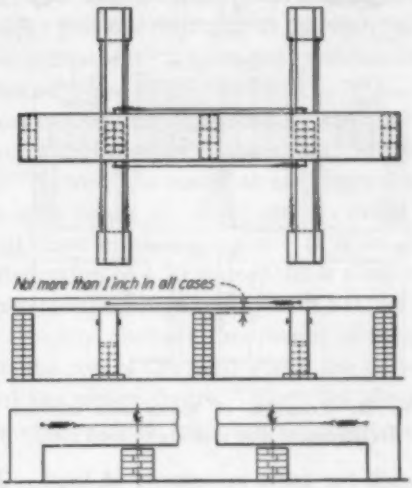


FIG. 2.—Location of safety piers.

VII. Method of Loading

(a) Determine weight of the brick used as a load. Weigh about 50 brick and determine the average weight of one brick.

(b) Safety Piers Before piling any load on the slab, construct five dry piers, three under the slab and one under each beam, as shown in Fig. 2. These piers should be the full width of the slab or beams and carried up to within one inch of the bottom, using wooden strips for the last two inches. The purpose of these piers is to sustain the load of the masonry and the brick load on top when the structure fails. *Considering the very high loads carried, the precautions mentioned are necessary to prevent accident.* The space between safety piers and the masonry should be maintained at about one inch, removing a board or brick in case the beams or slab deflect too near the safety piers.

(c) Piling Brick on Slab To load the structure, dry brick piers are laid on the slab, as shown in Fig. 3. The piers are built 2 brick wide and 3 brick long across the slab. A clearance of

1 inch must be maintained between all piers so that adjacent piers will not touch each other. This prevents arching of the load. Ten piers are sufficient for the center span and five piers each for the two cantilevers. For every two courses placed on the center span, one course is placed on each cantilever. This load becomes the increment used throughout the test and a series of deflection readings must be taken for each increment.

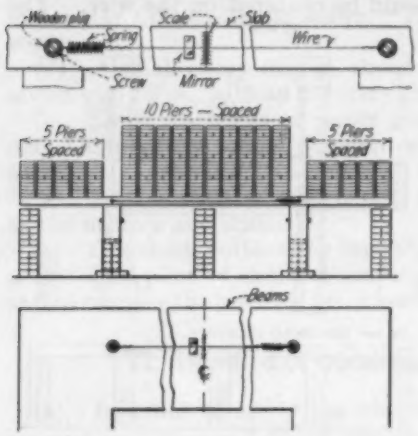


FIG. 3.—Location of scales and mirrors. Arrangement and spacing of load piers.

(d) Calculation of Load per Square Foot Each increment of load consists of two courses on the center span and one course on each cantilever. The center span will have two courses of 60 brick each or 120 brick for each increment of load. To obtain the load per square foot on the center slab per increment of load, multiply the number of brick, 120, by the weight per brick. This figure is the total load applied over an area equal to the width of the slab multiplied by the clear distance between beams. Thus dividing the total load by this area, expressed in square feet, the load in pounds per square foot is determined.

(e) Safety Measures Precautions should be taken to eliminate the possibility of any accident. Where the load becomes considerable it is of course necessary to use the utmost care in seeing that persons, unless they are thoroughly familiar with the testing, do not get beneath either the structure or the load. The piers built beneath both beams and slab will support the load in case of failure of either slab or beams. Sometimes the sudden drop of the structure where the height of the loaded brick is considerable, is sufficient to cause a toppling of the pile used for load, which of course becomes a serious matter. To reduce the likelihood of brick falling from the piles used for load, thin strips of wood, building paper, hoop iron, or even heavy cloth may be inserted in the horizontal joints, above three feet, to help bond the units together. The loading piers are purposely built free of each other so that there will be no arching of the load.

VIII. Recording Observations

(a) Routine Record all observations on a standard report sheet furnished by the Committee. Before applying any load at all

take a set of readings on all the scales. Apply one increment of load, consisting of one course of brick on each cantilever and two courses on center span of slab. Take a second set of readings of the scales and record. Then place a second increment of load exactly the same as the first. Again read each of the scales. Repeat this operation until the slab fails. In recording any reading of the scale compare it with the previous reading to make sure the readings are consistent.

(b) Special Observations Carefully note appearance of cracks, recording their location in the structure, width of opening, and load applied at first appearance. Record the loads at each increased width of cracks. Mark the cracks with chalk, *A*, *B*, *C*, etc., in order of their appearance, so that marks will show in photographs. It is important to note the load at which the deflection of 4.25 sixteenths is reached, as this is the limiting deflection for plastered ceilings on a span of 8 ft. The space between the stacks of brick directly above either beam is where transverse cracks usually appear in the top of the slab when the deflection has reached somewhere around the above figure. Sketches should be made showing just where cracks occur and the load at which they were noted.

IX. Photographs

In order to have a better record of the various events during a test it has been found desirable to take certain photographs, as follows:

(*a*) Structure before beginning the test.
(*b*) Load at first crack.
(*c*) Load at first large increase in deflection.
(*d*) Load at 30 courses of brick on center slab.
(*e*) Load at each additional 4 courses.
(*f*) Load at failure.
(*g*) Cracks at failure. Mark the cracks plainly with chalk and letter *A*, *B*, *C*, etc., in order of occurrence.
(*h*) View from top of slab after removing load to show the crack across the slab.
(*i*) Any other unusual feature of structure or load.

PRELIMINARY OUTLINE OF PROGRAM OF RESEARCH IN REINFORCED MASONRY*

By Edward E. Krauss and Judson Voodes

Introduction

A careful study of the development of various building materials into useful and economic members or parts of engineering structures shows much effort wasted by the courageous pioneering engineer and architect as well as the manufacturer. Again, the process of evolution of some

* Report No. 6 of Committee on Reinforced Brick Masonry.

raw materials into their modern economic forms has been rather prolonged, which in itself has created an economic loss. Considerable careful scientific research has been made where some of the fundamental factors were overlooked or not reported so that the results could not be correlated with the work of other investigators. Often in developing new applications of a product, research is fostered and directed by the manufacturer who is not trained in the rigid requirements of effective research.

This Committee, after a careful study of the history of reinforced brick masonry and of the numerous attempts on the part of engineers and others to carry on research, has come to the conclusion that a comprehensive research program should be set up and should be available to research men as a guide. The Committee realizes, however, that such a program cannot be the work of one man or a group of men, but must combine the thoughts of those qualified by training and experience to judge best what procedure should be followed and how executed. Therefore an Advisory Committee has been formed which consists of leading structural materials investigators of this country, to whom the attached suggested outline of a proposed research program is being submitted for study.

The outline has been prepared as a basis for discussion only. The Committee has attempted to include all factors brought out by a study of the tests thus far made and the experience gained in actual construction abroad and in this country. It was thought desirable first, to list all of the items having a direct bearing; second, to develop the nature of each test as to form or design; and third, to set up definite methods of procedure in testing. The first has partly been done and the others will develop as the program is discussed.

Experience in the field indicates that the mortar and its ingredients should have first consideration. It seems that brick of varying physical characteristics, especially the rate of absorption, require different mortars. A standard mortar composed of standard Portland cement and standard Ottawa sand, that could be produced in any testing laboratory, would no doubt serve as a useful medium of comparison with mortars made of local sands. It has been found that a good, clean, sharp sand is necessary in place of many of the sands now used in brick mortar.

Before reinforced brick masonry can be generally applied by the design engineer and accepted by the building inspector, the fundamental principles of design must be established together with the necessary precautions to be observed during construction in the field.

The Committee hopes to coöperate with committees of other organizations working on problems having a bearing on reinforced brick masonry.

It was thought desirable to publish this outline of research at the time

of its submission to the Advisory Committee so that suggestions might be forthcoming from others who have had actual experience in reinforced brick masonry.

A list is appended of those who have consented to serve on the Advisory Committee in order to assist in the development of research in reinforced brick masonry.

Advisory Committee

Theodore Crane, *Professor of Architectural Engineering, Yale University*, New Haven, Conn.
Raymond E. Davis, *Professor of Civil Engineering, University of California*, Berkeley, Calif.
Herbert J. Gilkey, *Head, Department of Theoretical and Applied Mechanics, Iowa State College*, Ames, Iowa
S. C. Hollister, *Professor of Structural Engineering, Purdue University*, LaFayette, Ind.
Thomas R. Lawson, *Professor of Civil Engineering, Rensselaer Polytechnic Institute*, Troy, N. Y.
Inge Lyse, *Research Assistant Professor of Engineering Materials, Lehigh University*, Bethlehem, Pa.
F. M. McCullough, *Head, Department of Civil Engineering, Carnegie Institute of Technology*, Pittsburgh, Pa.
Charles E. O'Rourke, *Assistant Professor of Structural Engineering, Cornell University*, Ithaca, N. Y.
D. E. Parsons, *Chief, Masonry Construction Section, Bureau of Standards*, Washington, D. C.
E. F. Richart, *Professor of Structural Engineering, University of Illinois*, Urbana, Ill.
J. R. Shank, *Professor of Civil Engineering and Research Professor, Engineering Experiment Station, Ohio State University*, Columbus, Ohio
Lorenz S. Straub, *Professor of Structural Engineering, University of Minnesota*, Minneapolis, Minn.
J. T. Thompson, *Professor of Structural Engineering, Johns Hopkins University*, Baltimore, Md.
R. G. Tyler, *Dean, College of Engineering, University of Washington*, Seattle, Wash.
Walter C. Voss, *Professor of Building Construction, Massachusetts Institute of Technology*, Cambridge, Mass.
Alfred H. White, *Professor of Chemical Engineering, University of Michigan*, Ann Arbor, Mich.
M. O. Withey, *Professor of Mechanics, University of Wisconsin*, Madison, Wis.

I. Materials

1.1 Cement

1.11 Portland (Standard A.S.T.M.).
1.12 High early strength.
1.13 Natural.
1.14 Patent of various kinds.

1.2 Lime

1.21 Hydrated (Standard A.S.T.M.) calcium and magnesium lime.

1.22 Slaked lump quicklime.

1.3 Sand

1.31 Standard Ottawa (A.S.T.M.).

1.32 Commercial sands used in various districts.

Determinations: Sieve analysis and percentage of silt.

1.4 Water. Analysis and silt content.

1.5 Reinforcement

1.51 Medium steel in the form of rounds, squares, flats and hoop iron, ovals, expanded metal, and perforated flats.

1.52 High strength steel in the form of rounds, squares, flats, ovals, expanded metal, and wire of single strand and multiple strand without cores.

Determinations: Yield point and ultimate strength in tension.

1.6 Brick (clay or shale or mixture thereof).

1.61 Stiff-mud process: end-cut single stream, end-cut double stream, and side-cut.

1.62 Soft-mud process.

1.63 Dry-press process.

Determinations:

(*A*) Compressive strength: flat, on edge, and on end.

(*B*) Modulus of rupture on 7-in. span: flat and on edge.

(*C*) Absorption: 5-hr. boil, 24-hr., and 48-hr. cold water.
Rate of absorption: 1, 5, 10, 30, and 60 minutes, expressed as percentage of total on 24-hr. cold water.

(*D*) Classification: building, paving, or sewer brick

(*E*) Size of brick and weight.

(*F*) Trade classification: soft, hard, medium, and vitrified.

(*G*) Locality of manufacture.

(*H*) Raw materials: shale, surface clay, or mixture.

1.7 Hollow Tile

Determinations:

(*A*) Compressive strength: flat, on narrow side, and on end.

(*B*) Modulus of rupture.

(*C*) Absorption: 5-hr. boil, 24-, and 48-hr. cold water.
Rate of absorption: 1, 5, 10, 30, and 60 minutes, expressed as percentage of total on 24-hr. cold water.

(*D*) Classification: load-bearing, partition.

(*E*) Size of unit: overall, number of cells, thickness of walls, and weight.
(*F*) Trade classification: soft, hard, medium, and vitrified.
(*G*) Locality of manufacture.
(*H*) Raw materials: shale, surface clay, or mixture.

II. Mortar

Mortar to be of such consistency as to make it workable, leave trowel clean, and be readily packed around reinforcement. Establish a standard mortar and grout.

2.1 Mixtures

2.11 Standard 1 part Portland cement, 3 parts Ottawa sand.
2.12 1 Portland cement, 0.15 hydrated lime, 3 sand.
2.13 1 Portland cement, 1 hydrated lime, 6 sand.
2.14 Special mixtures, using high early strength cement.
2.15 Commercial ready-mixed.

2.2 Grout Standard mortar plus .... per cent of water; also other mixtures.

Determinations:

(*A*) Strength: relation of thickness of joints of 1/2, 3/4, and 1 in. in compression, tension, and shear.
(*B*) Volume changes during hardening and due to temperature changes (100°) and moisture variation.
(*C*) Weathering.
(*D*) Freezing and thawing.
(*E*) Effect of waterproofing compounds.
(*F*) Effect of nonfreezing compounds.

III. Bond Strength of Mortar

Use mortar of various mixtures: see 2:1 mortar mixtures.

3.1 Adhesion

3.12 Mortar to brick in direct tension.
3.13 Mortar to reinforcement. See 1.5 reinforcement for various shapes and types. Use sizes equivalent in cross-sectional area to rounds of 1, 1/2, 3/8, 1/4, and 3/16 in. diameter. Determine effect of mortar thickness around steel 1/8 and 1/4 in.

3.2 Shear

3.21 Mortar to brick with various size joints 1/2, 3/4, and 1 in. for various mortar mixtures.

Determinations:

(*A*) Type of mortar joint, shoved full, grooved, and grouted.
(*B*) Percentage of unsatisfied absorption in brick.
(*C*) Method of curing.
(*D*) Method of pointing joint.

IV. Tests of Beams

4.1 Beams of brick only
4.2 Beams of hollow tile only
4.3 Beams of brick and hollow tile
4.4 T-beams erect and inverted
4.5 Cantilever beams

Size of beams

Width: 8, 13, and 16 in. or two, three, and four brick wide.
Depth: To suit span and width.
Span: 8, 12, and 20 ft.

Design of beams: Definite designs should be prepared covering

(*a*) Brick bonded lengthwise and not bonded.
(*b*) With and without headers on end and flat.
(*c*) Soldier courses of brick on end and brick on edge.
(*d*) Varying percentages of tension steel.
(*e*) With and without webb reinforcing.
(*f*) Steel with and without hooked ends.

Mortar: Various mixtures, especially straight Portland and high early-strength cements.

Age at test: 2, 10, 30 days, 3 months, and 1 year.

Determinations: In addition to the usual data on structural stresses in masonry and reinforcement, observations should be made on volume changes due to hardening of mortar, and temperature and moisture changes.

V. Test of Slabs

5.1 Plain slabs of brick only
5.2 Plain slabs of hollow tile only
5.3 Plain slabs of brick and hollow tile
5.4 Cantilever slabs
5.5 Continuous slabs
5.6 Slabs supported on four sides and cross-reinforced

Size of Slabs:

Thickness: $2^1/_4$, 4, 6, and 8 in. or one brick width to one brick length
Span: 6, 8, 12, and 20 ft.

Design of Slabs: Definite designs should be prepared covering

(*a*) Placement of brick and bonding.
(*b*) Brick grouted and trowel laid.
(*c*) Varying percentages of reinforcement.
(*d*) Steel with and without hooked ends.

Mortar: Various mixtures, especially straight Portland and high early-strength cements.

Age at test: 2, 10, 30 days, 3 months, and 1 year.

Determinations: In addition to the usual data on structural stresses in masonry and reinforcement, observations should be made on volume changes due to hardening of mortar, and temperature and moisture changes.

VI. Tests of Columns

6.1 Columns of brick only

6.11 All brick trowel laid.
6.12 Outside brick trowel laid, center or core with bats, etc., grouted.

6.2 Columns of hollow tile

6.3 Columns of brick and hollow tile

Size of Columns:

Section: Rectangular: 8, 13, and 16 in.
Round: 13 and 16 in.
Height: 8, 12, and 20 ft.

Design of Columns: A definite design should be prepared covering

(*a*) Placement and bonding of brick.
(*b*) Varying percentages of vertical and hoop steel.
(*c*) Structural steel shapes with and without hoops.

Mortar: Various mixtures, especially straight Portland and high early strength cements.

Age at Test: 2, 10, 30 days, 3 months, and 1 year.

Determinations: In addition to the usual data on stresses in masonry and reinforcement under concentric and eccentric loading, observations should be made on volume changes due to hardening of mortar, and temperature and moisture changes.

VII. Tests of Walls

7.1 Walls of brick only
7.2 Walls of hollow tile only
7.3 Walls of brick and hollow tile

Size of Walls: $2^1/_4$, 4, 8, and 13 in. thick.
Type of Walls: Supported at bottom and also hanging from side walls.
Design of Walls: A definite design should be prepared covering
(*a*) Placement of brick or tile.
(*b*) Varying percentages of horizontal and vertical reinforcement.

Mortar: Various mixtures, especially straight Portland and high early-strength cements.
Age at Test: 2, 10, 30 days, 3 months, and 1 year.
Determinations: In addition to the usual data on stresses in masonry and reinforcement under vertical loads and side pressures, observations should be made on volume changes due to hardening of mortar, and temperature and moisture changes.

VIII. Tests of Retaining Walls

8.1 Cantilever
8.2 Counterforted
8.3 Buttressed
8.4 Wall supported top and bottom

Design of Walls: A definite design should be prepared after study of commercial requirements.

Mortar: Various mixtures, especially straight Portland and high early-strength cements.

Age at Test: 2, 10, 30 days, 3 months, and 1 year.

Determinations: In addition to the usual data on stresses in masonry and reinforcement under vertical loads and side pressures, observations should be made on volume changes due to hardening of mortar, and temperature and moisture changes.

IX. Tests of Curved Structures

A study should be made to determine the proper designs for test to secure test structures representative of sewers, culverts, aqueducts, water-tanks, tank enclosures, bins, etc.
Mortar: Various mixtures, especially straight Portland and high early-strength cements.
Age at Test: 2, 10, 30 days, 3 months, and 1 year.
Determinations: In addition to the usual data on stresses in masonry and reinforcement under vertical loads and side pressures, observations should be made on volume changes due to hardening of mortar, and temperature and moisture changes.

X. Tests of Arches

This should include full arches, cantilever arches, and domes.

Design: A careful study should precede making a representative design.

Mortar: Various mixtures, especially straight Portland and high early-strength cements.

Age at Test: 2, 10, 30 days, 3 months, and 1 year.

Determinations: In addition to the usual data on stresses in masonry and reinforcement under vertical loads and side pressures, observations should be made on volume changes due to hardening of mortar, and temperature and moisture changes.

XI. Tests of Piers and Footings

A study should be made of existing data and then a design for test determined upon.

Mortar: Various mixtures, especially straight Portland and high early-strength cements.

Age of Test: 2, 10, 30 days, 3 months, and 1 year.

Determinations: In addition to the usual data on stresses in masonry and reinforcement under vertical loads and side pressures, observations should be made on volume changes due to hardening of mortar, and temperature and moisture changes.

XII. Tests of Fire Resistance

Inasmuch as tests have already been made on plain masonry walls, it would seem that the first efforts should be directed to determine the embedment necessary to protect the reinforcement properly in beams, columns, and slabs for various mortars.

Mortar: Various mixtures, especially straight Portland and high early-strength cements.

Age at Test: 2, 10, 30 days, 3 months, and 1 year.

TENTATIVE SPECIFICATIONS FOR REINFORCED BRICK MASONRY*

I. Tentative Specifications

By Edward E. Krauss and Judson Vogdes

(1) Forms

All forms shall be constructed of sound timber, rigidly supported so as not to be displaced under the weight of materials and workmen, and be readily removable without jar to brickwork.

* Report No. 7 of Committee on Reinforced Brick Masonry.

The forms shall be straight, not warped, set true to dimensions with wedges and supported free of brickwork having mortar of less than 48 hours set.

Forms for beams or lintels shall be of planks 2 inches thick.

Forms for floors or roof slabs shall be sufficiently rigid to support adequately the work so as to hold it true to the dimensions given on plans.

(2) Brick

(a) Strength The brick shall meet at least Grade B of the Standard Specifications for Building Brick (from clay or shale) of the A.S.T.M. (C62-30) or Grade H of the Federal Specifications Board.

(b) Absorption Brick having an absorption of *less than 2%* (5-hr. boil) shall be subjected to a mortar-bond test to determine best mortar mixture and water content necessary to secure proper bond of mortar to brick.

Brick having an absorption of from *2 to 10%* (5-hr. boil) shall be wetted before use only in hot dry weather.

Brick having *more than 10%* (5-hr. boil) absorption shall be wetted sufficiently to prevent a too rapid absorption of mortar water.

(3) Cement

The cements used shall be as designated and shall meet the following specifications of the A.S.T.M.:

Standard Specifications for Portland Cement (C9-30).
Tentative Standard Specifications for High Early Strength Portland Cement (C74-30T).

(4) Lime

The lime used shall be as designated and shall meet the following specifications of the A.S.T.M.:

Standard Specifications for Hydrated Lime for Structural Purposes (C6-24).
Standard Specifications for Quick Lime for Structural Purposes (C5-26).

(5) Sand

The sand shall be clean, sharp, well graded from coarse to fine, and preferably washed. Sand containing silt or clay shall not be used. Great care shall be taken in selecting the sand which shall be of the same grade generally used in reinforced concrete. The sand shall meet the Definition of Sand for Structural Purposes of the A.S.T.M. (C58-28).

(6) Reinforcing Steel

The reinforcing steel shall be as called for on the plans, plain or deformed, meeting the following Standard Specifications of the A.S.T.M.:

Specification for Billet Steel Reinforcing Bars (A15-30).
Specification for Rail Steel Concrete Reinforcing Bars (A16-14).

All bars shall be cut to length and bent as per plans. Bars bent out of shape shall be carefully straightened. The steel shall be free from oil, grease, and reasonably free from heavy rust and scale. Bars, where necessary, shall be overlapped 40 diameters and wired together.

(7) Mortar

The mortar shall in general be made in the proportions called for in the plans. If not especially noted, the mortar shall be made of 1 part Portland cement, 1 part hydrated lime, and 6 parts sand. The quantities used shall be proportioned by volume, thoroughly mixed dry and sufficient water added to produce a workable mortar that will leave the trowel clean and will readily flow around the reinforcement under pressure of the trowel.

Mortar that has taken its initial set shall not be used.

Where high strength or early strength is desired, mortar shall be mixed 1 part cement and 3 parts sand, using Portland or high early strength cement.

All work shall be kept wet to prevent drying out of mortar before its initial set, especially in slabs and to within one foot of all joints holding reinforcement.

(8) Grout

When plans call for grouting, thin the regular mortar with water until it readily flows to the bottom of the brick joints and completely encases the reinforcing. Care shall be taken to keep grout as thick as possible and yet secure the above result. All grout shall be poured into each joint with a can having a spout, and not slushed over the whole surface.

(9) Bricklaying

(a) Beams and Walls All brick shall be accurately laid in position and bonded as called for by the plans. All joints shall be completely filled with mortar. In spreading a bed of mortar it shall not be grooved with the point of a trowel. All joints shall be shoved, not butted. The reinforcing steel shall be carefully placed in the proper mortar joint called for by the plans. All bars shall be completely surrounded by mortar and the bars shall clear all brick by at least $^1/_8$ inch.

(b) Slabs All brick for a slab or section of floor or roof shall be laid out dry on the forms in the position called for by the plans. The reinforcing called for shall be placed in the dry joints, supported in the

proper position vertically by blocks or chairs. Then the brick shall be wetted down and the grout poured. Care shall be taken that the grout readily flows under the reinforcing steel. The grouting shall proceed longitudinally with the bars, and in case of cross-reinforcing, grout longitudinally to the set of bars of the shorter span.

(10) Removal of Forms

Before removing forms the mortar joints shall be examined for hardness and if satisfactory the forms can be removed as noted below, the time being variable depending upon the weather. When using high early strength cements the time given can be reduced by one-half.

(a) Beams and Lintels *Up to 8-ft. span* and carrying no floor slabs or joists, seven (7) days. When floor or joist loads are carried, twenty (20) days.

More than 8-ft. spans, ten (10) to twenty (20) days depending upon the span, loads carried, and weather.

(b) Slabs *Up to 8-ft. span*, and carrying no partition walls, ten (10) days. When slabs carry partition walls they shall be supported by posts underneath the partition walls for ten days additional.

More than 8-ft. span, fifteen (15) to twenty (20) days, depending upon the conditions of load and the weather.

(11) Inspection

Careful inspection shall be maintained so that no mortar with initial set is used. Each day the mortar on previous days' work shall be examined for hardening and if not set sufficiently hard in twenty-four (24) hours, the work shall be removed and rebuilt. This inspection shall be especially rigid when using high early strength cement.

II. Appendix

The following quotations are from Notes on Reinforced Brickwork by A. Brebner, of the Indian Government, and are here reprinted to give the views of one who has probably designed and constructed more work than anyone else.

(1) Practical Execution of Reinforced Brickwork

"In the preceding sections a brief general description of reinforced brickwork has been given and it has been claimed that it is easier and simpler to construct than reinforced concrete work. It is now proposed to give attention during construction, and to offer suggestions which are likely to be found of practical use in carrying out work.

"The main requisites of good reinforced brickwork are (1) sound centering, (2) good materials, and (3) careful work.

(2) Centering

"As in reinforced concrete work, some form of centering is required on which the work can be constructed and supported until such time as the mortar has set. Elaborate and expensive centering such as is essential in reinforced concrete work is, however, not required.

"The simplest type, and that which is most generally used, consists of a platform composed of planking or sheeting at the required level, supported on runners or beams, and covered with a thin layer of well-beaten earth finished off with a sprinkling of fine sand.*

"It is essential that whatever centering be used it should possess the following properties: (1) rigidity, (2) simplicity of construction, slackening, and removal, and (3) a smooth surface on which to lay the slab.

"The centering must be rigid. By this is meant it should not sag under the weight of the workmen constructing the slab. It should be tested beforehand by being jumped on, and if there be anything very perceptible in the nature of a "give" about it, further stiffening should be provided.

"No special difficulties are likely to be met with in erecting centering. The following points should, however, be noted at this stage:

(1) Care must be taken to see that all centering planking is kept clear of the bearings for the slab and rests on cross-beams only.
(2) If planks are used they should not be laid too close to each other as they may jam and there may be difficulty in removing them.
(3) All cross-beams should be carried on the walls, supported at intervals, if necessary, by rough timbering (bullahs) or temporary dry brick pillars.
(4) Cross-beams should rest directly on wedges and not on the supporting walls themselves. This permits centering to be easily and rapidly struck and removed, and does away with any chance of jarring the finished work.

"The length of time for which centering should be left up after construction depends on many conditions, such as the specification of mortar used, the season of the year, and the span of the beam or slab. It is, therefore, not possible to lay down any hard and fast rules on the subject. The practice followed in Patna, as noted below, may be taken as a guide:

(1) Centering for ordinary slabs from a minimum of about five days in summer to a maximum of about 10 days in winter provided there is no frost.
(2) Centering for specially heavily reinforced slabs from 7 days to 15 days.
(3) Centering for ordinary beams 10 to 15 days.
(4) Centering for important beams carrying heavy loads 28 days.

"Where T-beams of reinforced brickwork are combined with the re-

---

* Dressed lumber is not readily available in India.

inforced brickwork slab, several arrangements of centering are possible, but whatever arrangement is adopted, care must be taken to see that it is possible to remove the slab centering without interfering in any way with that for the beam. This is essential as the slab centering is invariably removed some days before the rib centering.

"In constructing reinforced brickwork ceilings below tile or other sloping roofs, the centering may be simply hung from the lower member of the supporting trusses by means of specially constructed clips. This method was successfully employed during the construction of the Secretariat Building at Patna where 130,000 sq. ft. of ceiling were laid.

"When the time comes to ease and remove centering, great care must be taken to see that no jarring of any kind occurs. All wedges should first of all be carefully drawn. This separates the supporting beams and planking from the reinforced brickwork construction and readily permits the removal of the centering and the supports. In fact, all operations in connection with the removal of centering must be gently performed. It is desirable to impress this on every one connected with the work at the very outset; otherwise accidents may occur and in any case centering is needlessly damaged and destroyed.

(3) Materials

"The materials used in reinforced brickwork are (*a*) brick, (*b*) cement, (*c*) sand, and (*d*) steel reinforcement. Only the best brick complying with the usual first class specifications should be used in reinforced brickwork. Hardness is a desirable quality, but brittleness is not, while a smooth glaze on the surface, such as is sometimes observed in overfired brick, is undesirable as mortar will not adhere well to brick with such a surface.

"The following qualities are also desirable:

(1) Low Absorption: If nothing else is obtainable and porous brick have to be used, working stresses must be correspondingly reduced.
(2) Freedom from Saltpeter: Brick having too much saltpeter are unsuitable for reinforced brickwork and should not be used.

"It is also advisable to test specimens of the brick intended to be used in reinforced brickwork, both in tension and compression.

"Sand should be clean, well graded, *i.e.*, there should be particles of all sizes from $^3/_{16}$-in. diameter to the very finest grains, and if possible, sharp. Sharpness is not absolutely essential if the grading is good and the sand otherwise sound. It should be free from organic and vegetable matter, and should also be as free from clay and mica as possible. Although some authorities are of the opinion that the presence of small quantities of clay actually improves cement mortar, there is always the fear that if too much be allowed the mortar will be weakened.

"The presence of mica in the sand is objectionable, as a micaceous sand re-

quires a greater proportion of cement to produce a mortar equal in strength to mortar made from a sand free from mica and otherwise equally good. Unfortunately, most sands are micaceous and the only thing to be done is to determine by actual experiments the proportion in which it has to be mixed with cement to produce a suitable mortar.

"Too fine sand should not be used as it requires extra cement to be added to produce good mortar.

"The mortar used should consist of cement and sand in proportions varying according to the quality of sand available. (Throughout work at Patna the proportions used were 1 of cement to 3 of sand by volume, mixed dry, and it was found that this gave satisfactory results.) Only enough water should be added to make the mortar of such a consistency that is workable, leaves the trowel clean, and can be readily packed around the reinforcement bars.

"Only the best mild steel should be used as reinforcement. As far as possible only steel of circular section should be used. Square sections may also be used, but flats or angles should be avoided. If they have to be used care should be taken to see that the bond stresses are kept very low.

"In floor and roof slabs no section of greater diameter than $^1/_2$ in. should be used, and as far as possible only small sections such as $^1/_4$, $^5/_{16}$, and $^3/_8$ in. should be used. Sections in beams should not be larger than 1 in. in diameter for main reinforcement and $^1/_2$ in. for shear reinforcement. Hoop iron, although unsuitable for slabs and beams, is suitable for reinforcing partition walls.

"A little rust on the reinforcement is desirable as it ensures good adhesion, but all loose and scaly rust should be removed prior to use. Hoop iron with a bluish glazed surface should not be used; if it has to be, then it should be immersed in water for a few days. This produces rusting and effectively destroys the glaze on the surface.

"The ends of all rods should be bent into semicircular hooks of a diameter at least six times the diameter of the rod itself with a short length of straight rod beyond the bend.

"As far as possible overlapping should be avoided by ordering rods of proper lengths, but where this cannot be done and overlapping has to be resorted to, a lap of 50 diameters should be given with proper hooks at the ends and the two rods should be bound with wire along the lap.

(4) Workmanship, Etc.

"The main points under this heading which require careful attention are as follows:

(*a*) That all brick are thoroughly soaked* before being used. This hardly requires any comment. Dry brick are sure to suck moisture out of the mortar joints and thus interfere with setting.

* Indian brick have a high percentage of absorption.

(*b*) That brick are properly arranged as they are laid. Where possible, the arrangement should be shown in drawings, but it may be laid down as a general principle that the joint should be broken wherever possible as this gives increased strength.

(*c*) That reinforcement is properly arranged. Before starting work all rods should be prepared and bent to the correct lengths and shapes shown in the drawings and where possible laid out *in situ*. If this is done difficulties will be anticipated and cutting and overlapping reduced to a minimum. Rods of the correct length should be used, but where this is not possible overlapping may be resorted to as detailed above. Welding should not be permitted.

(*d*) That all joints are well filled and all reinforcement well surrounded by mortar. This requires careful attention as workmen, unless watched, are apt to scamp the work or grout the joints. Both faults are objectionable and apt to lead to trouble unless checked. All reinforcement must be thoroughly surrounded by mortar, otherwise slipping and rusting may take place and adhesion, on which the strength of the structure depends, does not develop fully. Care should be taken that the bottom rods in slabs have a real cover of mortar under them and do not touch the centering surface.

(*e*) That the work after completion is properly looked after and watered. All work should be kept moist by means of wet straw, wet sand, or merely by sprinkling with water for the first and part of the next day after finishing. It should then be profusely watered and kept wet until one or two days before the removal of centering. A low mortar wall or kiari might be made all around the slab to hold about $^1/_2$ in. depth of water on it. A clear day should be allowed for dry setting before the centering is removed. The work should be kept wet or moist until it is about a month old.

(*f*) As far as possible, each structure should be finished in one operation and in one day, but there will be occasions when this is not possible and in such cases the following suggestions may be of use:

(i) Ordinary slabs supported on two sides may be left after finishing any layer of reinforcement.

(ii) Cross-reinforced slabs, *i.e.*, having reinforcement in two directions, may, if absolutely necessary, be left somewhere near the middle, that is, when half the slab from one side is laid.

(iii) Beams may be left near the center (section of least shear and maximum bending moment), but as far as possible these should be finished in one operation and as the size is seldom very large this can nearly always be done. Ordinary T-beams with a continuous slab in which all the shearing action has been provided for in the shape of stirrups may be left after completing the rib portion, provided the stirrups project from the rib almost to the top of the slab. The slab should be built over the rib not later than two days after completion of the rib. In all such cases the work on the remaining part of the structure should be resumed very early, the next day if possible.

(*g*) Careful removal of centering at the correct time and avoidance of shocks when carrying out this part of the work. This has already been dealt with when discussing the removal of centering. But it cannot be too often emphasized that anything in the nature of shocks is bound to be distinctly harmful."

CERAMIC ABSTRACTS[1]

Compiled by the

AMERICAN CERAMIC SOCIETY

Ross C. Purdy, Editor

Abstracters: A. Ally, C. R. Amberg, A. A. Avars, R. Barta, L. T. Brownmiller, E. C. Clemens, W. M. Cohn, R. H. Ewell, M. A. Ewer, J. L. Gallup, C. G. Harman, R. A. Heindl, E. B. Hewitt, H. Insley, M. V. Kondoidy, K. Lark-Horovitz, W. Lerch, T. N. McVay, W. W. Meyer, R. G. Mills, A. J. Monack, S. I. Perkal, E. P. Rexford, D. E. Sharp, G. R. Shelton, H. H. Stephenson, J. G. Tolpin, E. J. Vachuska, H. F. Viewig, M. J. G. Westfeldt, A. E. R. Westman, W. C. O. White.

Vol. 11 **May, 1932** **No. 5**

Abrasives

What is abrasive action? I. Fred B. Jacobs. *Abrasive Ind.*, **12** [11], 17–20 (1931).—J. discusses the difference between erosive and abrasive action. **II.** *Ibid.*, **12** [12], 18–21 (1931).—A lap is soft metal impregnated on its upper surface with an abrasive. A hone is a fine-grit sharpening stone. J. discusses in nontechnical and general terms the grinding action of different abrasives and abrasive tools. E.P.R.

Matching abrasive grain samples. Torrey Allen. *Metal Cleaning & Finishing*, **4** [2], 105–106 (1932).—The reasons for differences in gradings of abrasives are discussed. E.J.V.

Abrasives in industry. D. A. Eyre. *Metallurgia*, **1** [2], 52 (1929).—The manufacture of artificial abrasive wheels is described. M.V.K.

Surface-grinding machine with high-speed traverse. Anon. *Mech. World*, **91** [2354], 155 (1932).—Surface-grinding work on which an exceptionally high quality of straight-line finish is desirable can be obtained only with a machine using the periphery of a disk wheel. E.P.R.

Wheel tests to determine grinding costs. Firestone Steel Products Co. *Abrasive Ind.*, **13** [3], 13–14 (1932).—A grinding wheel test is of no value unless authentic data are tabulated to show the earning capacity of each wheel. Results of tests show the earning capacity of the rubber-bonded wheels used in grinding automobile tire rims. E.P.R.

Modernization of grinding plant. C. M. Elston and Francis A. Westbrook. *Abrasive Ind.*, **13** [3], 18–19 (1932).—The Collins Co., a century-old plant, combats the silica dust hazard by the use of modern grinding methods. E.P.R.

Buffing compositions. L. R. Eastman. *Brass World*, **28** [2], 33–34 (1932).—The raw materials are listed and described. The methods of control of raw materials include, in the case of oils, fats, and waxes, determinations of melting point, viscosity, color, odor, and other physical characteristics; in the case of abrasive powders, chemical analysis, complete screen analysis, and microscopic examination. E.P.R.

Lapping and honing as aids in precision work. Anon. *Abrasive Ind.*, **13** [3], 16–17 (1932).—Lapping, honing, polishing, and buffing practices are described. E.P.R.

Making special tools. Fred B. Jacobs. *Abrasive Ind.*, **13** [3], 7–10 (1932).—The making of special tools in small lots involves interesting grinding operations as exemplified at the plant of the National Tool Co. Many grinding jobs are briefly described. E.P.R.

Limit systems promote rapid production and assembly. H. W. Bearce. *Abrasive Ind.*, **13** [3], 11–12 (1932).—Tolerance is the permissible variation in a dimension, either

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
The bold-face number following the journal name is the volume, the issue number is in brackets followed by the page numbers, then the year in parentheses.

bilateral or unilateral. "Bilateral" is permissible variation in either direction from a specified size, and "unilateral" is permissible variation in one direction only. Interchangeable parts should be so nearly of the same dimensions that any part taken at random from a number of similar parts will, without further fitting or selection, assemble and function properly. E.P.R.

BOOK

Development of Grinding. ALFRED SCHROEDER. Verlag Petzold-Druck, Hoya-Weser, Düsseldorf, 1931. 218 pp. 153 illustrations. 5.40 Rm. unbound, 6.90 Rm. bound. Reviewed in *Glastech Ber.*, **10** [2], 110–11 (1932); for abstract see *Ceram. Abs.*, **11** [4], 221 (1932). M.V.K.

PATENTS

Segmental grinding wheel. THURE LARSSON. U. S. 1,843,287, Feb. 2, 1932.

Lapping machine. SYDNEY PLAYER AND HERBERT S. INDGE. U. S. 1,843,300, Feb. 2, 1932. ALEXANDER W. COPLAND. U. S. 1,848,108, March 8, 1932.

Cam lapping machine. SYDNEY PLAYER AND HERBERT S. INDGE. U. S. 1,843,301, Feb. 2, 1932.

Rail grinding machine. CHARLES P. HOPLEY. U. S. 1,843,722, Feb. 2, 1932.

Abrading. MINER L. HARTMANN. U. S. 1,844,064, Feb. 9, 1932.

Magnetic grinding machine. FRANK L. PUTNAM AND FRED D. MORSE. U. S. 1,844,073, Feb. 9, 1932.

Abrading machine. FRANK KABELAC. U. S. 1,844,165, Feb. 9, 1932.

Abrasive composition. EDWARD A. NILL. U. S. 1,844,175, Feb. 9, 1932.

Boring and grinding machine. SAMUEL FRYCKBERG. U. S. 1,844,316 and 1,844,317, Feb. 9, 1932.

Emery wheel stand. ALEX DU MENIL. U. S. 1,844,749, Feb. 9, 1932.

Machine for sharpening saw teeth. LEE M. LOFTIN. U. S. 1,844,775, Feb. 9, 1932.

Roll grinding machine. CARL MOREY AND CARL F. SCHNUCK. U. S. 1,845,172, Feb. 16, 1932.

Abrasive compound. JOHN H. DRISCOLL. U. S. 1,845,250, Feb. 16, 1932.

Machine tool. SOL EINSTEIN AND LESTER F. NENNINGER. U. S. 1,845,865, Feb. 16, 1932.

Grinding machine. MAXWELL I. MATHEWSON. U. S. 1,846,132, Feb. 23, 1932. WARREN F. FRASER. U. S. 1,847,084, March 1, 1932. CLEMENT BOOTH. U. S. 1,847,588, March 1, 1932.

Method of grinding hobs. CARL G. OLSON. U. S. 1,846,272, Feb. 23, 1932.

Surface grinding machine. KARL JUNG. U. S. 1,846,341, Feb. 23, 1932.

Honing device for cylinders. JOSEPH SUNNEN. U. S. 1,846,371, Feb. 23, 1932.

Method of feeding articles to grinding machines. ALBERT VUILLEUMIER. U. S. 1,846,661, Feb. 23, 1932.

Grinding machinery. SOL EINSTEIN, LESTER F. NENNINGER, AND FRED HAAS. U. S. 1,846,956, Feb. 23, 1932. GEORGE W. BINNS. U. S. 1,847,466, March 1, 1932.

Forming attachment for roll grinders. ALBERT G. BELDEN AND JOSEPH R. WHITTLES. U. S. 1,847,167, March 1, 1932.

Truing mechanism for grinding wheels. RALPH E. FLANDERS. U. S. 1,847,337, March 1, 1932.

Grinding or abrading machines. A. E. WHITE. Brit. 365,563, Feb. 3, 1932. J. CASH AND DENBIGH ENGINEERING CO., LTD. Brit. 366,231, Feb. 10, 1932. CINCINNATI MILLING MACHINE CO. Brit. 366,462, Feb. 17, 1932. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 366,466 to 366,468, Feb. 17, 1932.

Centerless grinders. CINCINNATI GRINDERS, INC. Brit. 366,005, Feb. 10, 1932 and 366,548, Feb. 17, 1932.

Grinding and stropping apparatus for razor blades. A. STEINNER-GÖLTL. Brit. 366,333, Feb. 10, 1932.

Machines for polishing or grinding. AUSTIN MOTOR CO., LTD., AND F. C. DOLBY. Brit. 366,599, Feb. 17, 1932.

Art and Archaeology

Applying metallic decorations on glass and pottery ware. ROESSLER & HASSLACHER CHEMICAL CO. *Ceram. Ind.*, **18** [3], 170–73 (1932).—For affixing metal to glass, glaze, or enamel, two general methods are in use: (1) actual deposition of the metallic coating on the ware, as in electrodeposition or precipitation (this method is now of small importance in decoration), and (2) the firing method by which the powdered metal is fixed to the ware. A discussion of these preparations and the general methods of applying or fixing them to ceramic ware is given. W.W.M.

Effects of various gases present in the kiln on the firing of gold for ceramic ware. AKIRA NAKATSUCHI. *Jour. Soc. Chem. Ind.* [Japan], **34** [2], 67–69*B* (1931); *Chim. & ind.*, **26** [3], 637 (1931).—N. found that SO_2, SH_2, CO, H_2, and CO_2 are injurious to bright gold. The best though impracticable atmosphere is nitrogen with some oxygen. N. also studied the action of these gases on different gold balsams (composed of terpen-sulphide and gold), *e.g.*, gold balsam and resinate of bismuth, gold balsam and resinate of chromium, and gold balsam and resinate of rhodium. Steam does not seem to decompose bright gold. M.V.K.

New colors in glass. ANON. *Crockery Glass Jour.*, **110** [2], 63 (1932).—Golden glow is the newest color in the line of the Federal Glass Co., now on display in the Chicago showrooms. In addition, crystal and green are being featured. Golden glow is especially appealing in combination with Federal Madrid etching. E.P.R.

New decorative pottery. ANON. *Arts & Dec.*, **36** [5], 36 (1932).—Many new forms are appearing for the garden and sun room including figures, unique jars, etc. E.B.H.

Pottery school of the South. J. V. H. *Christian Sci. Mon.*, **24** [90], 10 (1932).—For 34 years the art school of Sophie Newcomb College, New Orleans, La., has been producing a typically southern pottery of rare beauty. Some of the products of this school are described as to color, design, and type of glaze applied. The pieces are all made by hand. The class of products made is described. Illustrated. E.J.V.

Irregular designs in modern French glass. ANON. *Arts & Dec.*, **36** [4], 19 (1932).—This is a page of illustrations of primitive models, mostly animals, in amusing glassware which seem in vogue in Europe and America. E.B.H.

Italian ceramists. LUIGI MOSCA. *Corriere Ceram.*, **13** [1], 11–15 (1932).—The more extensive manufacture and domestic use of high-fired artistic ceramic ware is urged. M.V.K.

Audac exhibit of modern industrial and decorative art at the Brooklyn Museum. C. ADOLPH GLASSGOLD. *Creative Art*, pp. 437–40 (June, 1931).—This union of American designers and craftsmen (Audac) is presenting a comprehensive exhibit of the work of its members. While the reviewer accords it high praise, he points to a serious discrepancy between the theory of modern design as a concession to machine and mass production and the actual machine products and their relative costliness. He suggests that if this exhibition becomes an annual affair, manufacturers will be less recalcitrant about using new American designs. (*D.I.*)

Modern china from all over the world. ANON. *Arts & Dec.*, **36** [5], 22–23 (1932).—Two pages show illustrations of modern china of quality in great variety. E.B.H.

American art notes. American pattern glass. ANON. *Connoisseur*, **89** [366], 138–39 (1932).—American pattern glass post-dating Colonial, Revolutionary, and early Federal periods is receiving consideration. Each piece was cast in two or more mahogany molds but designs, not one-factory products, were loaned, making classification difficult. Sandwich glass is outstanding, especially the "lacy" and the tulip patterns. Baltimore Pear was peculiar to the South. The Lion Cable, Westward Ho, Lincoln Drape, and others reflect period history. Thumb-in-Square showed a depression as of a thum centering each square, and Honey-Comb, Star, and Moon, etc., indicate their character. Although most of the pattern glass was clear, some blue, amethyst, and yellow appeared, the composition of the last being now a lost art. Illustrated. E.B.H.

Painting on glass. ANON. *Design*, **33** [8], 187 (1932).—An illustration is given of glass painting in the peasant manner of 100 years ago. There are four sheets of glass on each of which a part of the composition is painted making the whole resemble a stage. E.B.H.

Double glaze Satsuma. LADY INGRAM. *Connoisseur*, **89** [366], 109–15 (1932).—A loan exhibition at the Victoria and Albert Museum includes 78 pieces of rare old Japanese double glaze Satsuma of which very little is known. Satsuma was produced in the 15th Century and reached its height in the 17th and 18th Centuries. It is a dark stoneware, the paste varying from dark biscuit shade to grayish black. The fluid glaze was applied in two layers which were not to become fused, thus presenting many technical difficulties. The glaze varied from ivory to deep treacle color. The two distinct crackles obtained from separate firings are distinct and result in a meshwork of bold and fine lines. Imperfections in the second glaze could be filled with thick enamel colors. Many of the pieces depend solely upon the superb quality and shape minus decoration, some are sparingly decorated with motifs, while others have bands of Satsuma Kinrande (gold brocade). Figures are rare. Illustrated. E.B.H.

Derby china factory. W. WILLIAMSON. *Connoisseur*, **89** [365], 44 (1932).—W. has proof from old news records that the Derby Porcelain Factory existed at Nottingham Road as early as 1753. E.B.H.

Glass ornaments of Gabo. J. BIER. *Glastech. Ber.*, **10** [1], 40–41 (1932).—B. describes some of the glass objects produced by Gabo and gives his biography. Illustrated. M.V.K.

Snake-worship pottery from Cyprus. DIKAIOS. *Illus. London News*, **179**, 891–93 (1931).—Remarkable prehistoric pottery representing religious rites to a snake god have been unearthed at Vounous. Illustrated. H.H.S.

Crete as the cradle of Greek art. DORO LEVI. *Illus. London News*, **179**, 1042–44 (1931).—A rich harvest of pottery and bronze found in the necropolis of Phrati, central Crete, shows that Crete was the mother of Greek art.' H.H.S.

BOOK

Mohenjo-Daro and the Indus Civilization. JOHN MARSHALL. 3 vols., 3rd. vol. Plates. Arthur Probsthain, London, 1931. Price 12 guineas. Reviewed, with illustrations, by Arthur Keith in *Illus. London News*, **179**, 1000–1004 (1931). H.H.S.

PATENTS

Design for bottle. BEN DOMONT. U. S. 86,155, Feb. 9, 1932. CHARLES L. GRIGG. U. S. 86,163, Feb. 9, 1932. BENJAMIN F. NELSON. U. S. 86,177, Feb. 9, 1932. ARTURO G. DE FAUZON. U. S. 86,222, Feb. 16, 1932. EDWIN W. FUERST. U. S. 86,306, Feb. 23, 1932.

Design for gas range. HENRY W. O'DOWD. U. S. 86,136, Feb. 2, 1932. DONALD L. HADLEY. U. S. 86,226, Feb. 16, 1932.

Design for jar. EDWIN W. FUERST. U. S. 86,118, Feb. 2, 1932. IVOR CORDY. U. S. 86,353, March 1, 1932. THEODORE J. PIAZZOLI. U. S. 86,408, March 1, 1932 and U. S. 86,470, March 8, 1932.

Design for bathtub. RAYMOND TRANE. U. S. 86,185, Feb. 9, 1932.

Design for plate. YUKIO BUMA. U. S. 86,195 to 86,213, Feb. 16, 1932.

Design for teapot, etc. YUKIO BUMA. U. S. 86,214, Feb. 16, 1932.

Design for creamer. YUKIO BUMA. U. S. 86,215, Feb. 16, 1932.

Design for sugar bowl. YUKIO BUMA. U. S. 86,216, Feb. 16, 1932.

Design for stove. CHARLES J. ROGERS. U. S. 86,409, March 1, 1932.

Design for combined stove and cabinet. CHARLES J. ROGERS. U. S. 86,410, March 1, 1932.

Design for gas stove. WILLIAM T. BRADBURY. U. S. 86,436 to 86,438, March 8, 1932.

Cement, Lime, and Plaster

Hydrate of lime and its action during the hardening of Portland cement. F. F. TIPPMANN. *Kolloid-Z.*, **55** [1], 85–107 (1931); *Sprechsaal*, **64** [45], 836–37 (1931).—The needle crystals appearing in cement prepared with excess water do not consist of monocalcium hydrosilicates as is generally assumed, because they are also formed by the hydration of pure CaO in the presence of a small quantity of a gypsum solution. The latter is used only as promoter of crystallization; its action is of a catalytic nature. The needle crystals consist of hydrate of lime and do not appear in normal, water-dosed, viscous cement because the cement granules lie too near each other. In the latter case, larger crystals of hydrate of lime of another shape (plates and prisms) are obtained. Concerning the crystallization of calcium hydroxide, it is to be determined whether pure CaO forms amorphous colloidal hydrates exclusively; but as long as an over-saturated $Ca(OH)_2$ solution is in contact with amorphous calcium hydroxide as ground substance, no crystallization of $Ca(OH)_2$ takes place. The presence of gypsum produces crystallization because when $CaSO_4$ and $Ca(OH)_2$ are both present in the solution simultaneously, high concentrations of Ca-ions prevail and, moreover, the available OH-ions greatly exceed the quantity of SO_4-ions. An initial "borrowing" of Ca-ions can be assumed from the gypsum solution which introduces the $Ca(OH)_2$ crystallization. Perhaps later a recrystallization of gypsum dihydrates appears when sufficient available Ca-ions are present from the ground substance later dissolved. The strength-increasing action of gypsum does not depend on an additive action of this eventual gypsum recrystallization but is based only on the stronger and more rapid $Ca(OH)_2$ crystallization catalytically promoted by the presence of gypsum. The "initial strength" of a cement depends first of all on the velocity of crystallization and on the quantity of crystallized $Ca(OH)_2$ formed. T. presents a new theory of hardening: The lime silicates decompose hydrolytically completely into a pure silica sol and hydrate of lime under the influence of water. The hydrate of lime goes molecularly into solution and separates the silica gel into flakes. A silica gel is thus formed in a saturated $Ca(OH)_2$ solution. The silica gels surround the separate clinker grains and an always increasing crystallization of the hydrate of lime takes place at once within and outside the silica gels, temporarily influenced also by the gypsum solution present. The solution which becomes poor in hydrate of lime is again enriched by only partly decomposed cement grains and silica gels are again formed. With a further growth of hydrate of lime crystals, a decrease in fluidity and a shrinkage of the silica gel take place simultaneously, but the cement grains continue to be decomposed. In the setting stage, the exterior shells of silica gels harden because the interior compression of the growing hydrate of lime crystals and the decrease in fluidity work together

in this direction. The channels and pores of the gels become narrower and the migration of the liquid is retarded. With the end of hardening, the whole system is in equilibrium. All the water is combined in the hydrate of lime crystals as water of crystallization. These have reached their maximum size and have completely dehydrated the silica gels by compression and brought them to a hardening free from shrinkage. The cement grains are not completely decomposed, for the ideal hardening is practically never reached, or only after a long time. The reason for lime expansion lies in the formation of amorphous hydrate of lime. The fact that a strongly lime-expanding cement is made volume-stable by additions of gypsum is based on the transformation of the amorphous hydrate of lime into the crystalline form under the catalytic influence of gypsum as is explained above. The known action of sugar which prevents crystallization in a set and hardened cement and which greatly promotes the colloidal phase was confirmed by T. It was found that the action of sugar consists in making colloidal the crystallizable hydrate of lime with which a large shrinkage and slow hardening of cement is connected. See also *Ceram. Abs.*, **11** [1], 9 (1932). M.V.K.

Researches on Portland cement and its constituents by means of steam pressure measurements. F. KRAUSS AND G. JÖRNS. *Zement*, **19** [45], 1054–55 (1930); **20** [14], 314–17; [15], 341–43 (1931); *Glastech. Ber.*, **10** [2], 87 (1932).—The micro-tensi-eudiometer was used for observing the giving off of water by cement during heating. The curves of the disintegration of the separate compounds ($CaSO_4 \cdot H_2O$; $CaCO_3$; $Ca(OH)_2$; SiO_2; MgO; Fe_2O_3) are explained. The testing melts were prepared by heating in the Knall blast apparatus. After grinding, setting with water, and drying in air, the preparates were analyzed and showed the following results: Hydrated $3CaO \cdot SiO_2$ has combined $2H_2O$; at 30 and 100°, stages in decomposition of the SiO_2, hydrates are indicated; at 350 to 400° appears the stage in decomposition of $Ca(OH)_2$ to $CaO \cdot 3CaO \cdot Al_2O_3$; it absorbs $4.5H_2O$, and shows stages at 120 and 200° due to Al_2O_3; 15 mol. water are expelled. The change of $Ca(OH)_2$ to CaO is only suggested at 350°. A melt of the $8CaO \cdot 2SiO_2 \cdot Al_2O_3$ composition combined about 12 mol of H_2O and showed a large number of faded stages up to 300° which, according to the authors, are symptoms of stable compounds. Four different samples of hydrated cements show many partly faded stages, but the formation of CaO proceeds continually. M.V.K.

Effect of storage on strength of Portland cement. L. R. DAVIES-GRAHAM. *Rock Prod.*, **35** [5], 56–57 (1932).—Data are obtained from strength tests on samples of cement stored in air, over water, and in an air-tight jar. Tests were made after storage of 7, 21, and 35 days under these conditions. Increase in strength is due to decrease in free lime content. W.W.M.

Researches on the hydration of Portland cement. VI and VII. KATSUZO KOYANAGI. *Jour. Soc. Chem. Ind.* [Japan], **33** [7], 276–77*B* (1930).—K. studied the influence of monocalcium phosphate on the hydration of cement and found that even a minimum quantity of monocalcium phosphate retards the setting process. These results were confirmed by microscopical investigations. **VIII. Hydration of lime aluminate in Portland cement.** *Ibid.*, **34** [8], 294–98*B* (1931).—Lime aluminate present in Portland cement first goes into solution during hydration, then combines with lime, and crystallizes again in the form of a thin, hexagonal lamella, whose chemical composition is $3CaO \cdot Al_2O_3 \cdot 10.5H_2O$. **IX and X.** *Ibid.*, **34** [11], 452–59*B* (1931).—During the hydration of Portland cement, the gysum combines with the lime aluminate of the cement and forms calcium sulphoaluminate of the composition $3CaO \cdot Al_2O_3 \cdot 3CaOSO_4 \cdot 32.6H_2O$. The calcium sulphoaluminate does not originate during the hydration of Portland cement if it contains less than 3 molecules of gypsum. With time, calcium sulphoaluminate again decomposes into gypsum and lime aluminate in the solution. For Parts I to V see *Ceram. Abs.*, **10** [5], 326 (1931). M.V.K.

Critical study of the recent works on hydration of calcium aluminates. HENRI LAFUMA. *Rev. mat. constr. trav. pub.*, No. 267, pp. 485–90 (1931); No. 268, pp. 9–15 (1932).—L. discusses (1) the action of water on the anhydrous calcium aluminates (*a*) hydrated tricalcium aluminate, (*b*) action of water on the aluminates $Al_2O_3 \cdot CaO$ and $3Al_2O_3 \cdot 5CaO$, (*c*) action of water on the aluminate $Al_2O_3 \cdot 3CaO$; (2) the results of researches of Thorvaldson, Grace, and Vigfusson (for abstract see *Ceram. Abs.*, **9** [1], 15 (1930)); (3) the researches of Travers and Schnoutka (for abstract see *ibid.*, **9** [9], 784 (1930)); (4) constitution of crystallized hydrated calcium aluminates; (5) mechanism of the dissolving in water of hydrated calcium aluminates; (6) relation between the different crystalline forms of aluminates and the p_H of the medium; (7) interpretation of the experimental results of L.; and (8) observations on the different points of view and theories concerning hydrated calcium aluminates. L. concludes that the complexity of the problem of hydration of calcium aluminates and the insufficiency of results obtained make necessary a continuation of researches on this question. M.V.K.

Hydrothermal syntheses of calcium silicate under pressure. I and II. S. NAGAI. *Jour. Soc. Chem. Ind.* [Japan], **34** [7], 222–24*B*; [9], 317–19*B* (1931).—Samples composed of mixtures of calcium oxide and silica in molecular proportion were heated under pressure in an autoclave for 1, 2, and 6 days, and then dried. The products obtained were examined for (1) the loss on ignition, (2) insoluble residue or free silica after treating with 10% sodium carbonate solution and 5% HCl, (3) combined silica, (4) total calcium oxide, and (5) uncombined calcium oxide after titration with ammonium acetate alcohol solution. The molecular ratios between the calcium oxide and silica were then calculated and compared. The results are tabulated. M.V.K.

Synthesis of calcium silicates. I and II. S. NAGAI AND K. AKIYAMA. *Jour. Soc. Chem. Ind.* [Japan], **34** [12], 471–73*B* (1931); **35** [1], 8–10*B* (1932).—Mixtures of $CaCO_3$ and SiO_2 (1:1 and 2:1) were calcined and heated to 900 to 1550°. The products obtained are discussed. Tests of the hydraulic properties show that $CaO \cdot SiO_2$ is much inferior to the calcium aluminates, but that its hydraulic strength increases slowly after long aging in water. M.V.K.

Setting of plaster of Paris. H. B. WISER AND F. B. MORELAND. *Jour. Phys. Chem.*, **36** [1], 1–30 (1932).—Thermometric and optical observations of the hydration of plaster of Paris were made to (1) throw light on the existence or nonexistence of gel formation as a stage in the setting process, and (2) formulate a general theory of the effect of foreign electrolytes on the rate of set. G.R.S.

Apparatus for simultaneous firing and grinding plaster of Paris. E. SCHNEIDER. *Tonind.-Ztg.*, **56** [7], 93–96 (1932). W.M.C.

Reactions during the setting of mixtures of ordinary and aluminous cements. H. E. SCHWIETE AND H. E. V. GRONOW. *Tonind.-Ztg.*, **56** [16], 222–24 (1932).—The addition of aluminous cement to ordinary cement will not change the strength of the cement in proportion to the amount of aluminous cement added. The setting time of the mixture also differs from that of the components. The basis of these observations is attributed to reactions occurring during the setting of the mixture which are not found with the setting of each of the components. An outline is given of the processes involved. W.M.C.

Researches on the reactions taking place in rotary cement kilns. T. HASHIMOTO AND K. AKIYAMA. *Jour. Soc. Chem. Ind.* [Japan], **34** [4], 130–32*B* (1931).—The results are tabulated and shown in diagrams. M.V.K.

Chemistry of gypsum. F. KRAUSS. *Tonind.-Ztg.*, **55** [88], 1222–24 (1931).—The papers by Nacken and Fill (see *Ceram. Abs.*, **10** [11], 755 (1931)) are discussed. The criticism of a publication by Linck and Krauss (see *Z. anorg. allgem. Chem.*, **137**, p. 407

(1924)) which is contained in the papers by Nacken and Fill is repudiated. See following abstract. W.M.C.

Phenomena appearing during dehydration of gypsum. R. NACKEN AND K. FILL. *Tonind.-Ztg.*, **55** [73], 1031–32; [75], 1057–59; [76], 1070–71 (1931).—The authors describe researches made on gypsum. (1) Tests in a vacuum showed that it is possible to remove a considerable part of the water of crystallization present in gypsum with a sufficient decrease of pressure and a sufficiently long testing time (30 days). (2) Gypsum crystals immersed in oil and heated to 102° for 162 hr. changed into the half hydrate. (3) Gypsum may be dehydrated in air and atmospheric pressure at room temperature when the partial pressure of the steam of the air is so small that it can draw water out of the gypsum. M.V.K.

Notes on analytical procedure as applied to the cement laboratory. DONALD C. PAQUET. *Rock Prod.*, **35** [5], 57–58 (1932).—P. suggests suction filtration, the use of the smallest size casserole possible, use of fresh ammonia, the dichromate method for iron, and the exercise of care to keep an oxidizing atmosphere within the platinum crucible during fusion to prevent the reduction of metals and their alloying with the platinum. W.W.M.

Definition of high-quality cements. T. KLEHE. *Tonind.-Ztg.*, **56** [9], 118–20 (1932). W.M.C.

Yugoslavic standard specifications for cement. ANON. *Tonind.-Ztg.*, **56** [12], 174–75 (1932).—The new specifications dated from Dec. 31, 1931, are reviewed. W.M.C.

Chemistry of the formation of cement. R. ZOLLINGER. *Zement*, **20** [32], 738–41 (1931); this is a correction on the reference given in *Ceram. Abs.*, **11** [3], 155 (1932). M.V.K.

Enamels

Coloring matter for sheet enamel. ANON. *Emaillewaren-Ind. (L'Émail)*, **9** [5], 1–2 (1932).—There are two methods of coloring enamels: (*a*) by adding the coloring matter to the raw composition of the enamel, *e.g.*, by fusing it with the enamel, and (*b*) by using it only as an addition to the mill. The coloring oxides usually fused with the enamel are (1) cobalt oxide producing blue and blue-violet, (2) manganese oxide for red-violet, (3) copper oxide for green or blue-green, (4) iron oxide for gray and brown, (5) nickel oxide for gray and green-gray, (6) chromium oxide for yellow, and (7) chromates for yellow or green-yellow. For transparent enamels (majolica enamels), the pigments are fused with the enamel and it is necessary that these pigments be soluble in the enamel; otherwise, the transparency would disappear. The composition of these pigments is similar to that of the oxides used in simple colored enamels. For opaque enamels, the colorants may be insoluble in the enamel. Pigments added to the mill produce different color effects depending on their properties and the chemical composition of the enamel. These pigments are usually solid solutions and their qualities and properties depend mainly on their chemical composition and on the temperature of their formation. The introduction of chromium oxide in the combination, cobalt oxide and aluminum oxide, produces different blue-green colorings. By adding zinc oxide and manganese oxide, numerous color variations are obtained. Mixtures of cobalt oxide and zinc oxide produce greenish colors; cobalt oxide + zinc oxide + chromium oxide produce blue-green colors. For obtaining green, chromium oxide is generally used. This green will have different tones when mixed with zinc oxide or magnesium oxide. A mixture of metallic oxide is used for obtaining a black color, although pure black does not exist, and the color called black is produced by several dark colors such as cobalt oxide, nickel oxide, copper oxide, manganese oxide, iron oxide, etc. According to the

quantity and properties of these oxides, the black color obtained appears to be bluish, greenish, or brownish. Gray colors are produced in the same manner. White opacifiers are added to black colorants, zinc oxide, aluminium silicate, antimony oxide, and sometimes tin oxide. For dark blue, cobalt oxide is fused with the enamel. Cadmium sulphide, chromates, and antimony compounds are used for the yellow color. For cream color, chromates of zinc, barium, and lead are used. The best red is obtained with selenium. By mixing it with cadmium sulphate, beautiful red colorings of different tones are obtained. For red-brown, iron oxide is used. Light red and pink are produced by the so-called "pink substances" obtained by heating tin oxide, quartz, carbonate of lime, and potassium bichromate. The preparation of these "pink colorants" is extremely difficult; the pink is greatly influenced by the composition and chemical properties of the enamel. Manganese dioxide and cobalt oxide fused with the enamel produce violet and its color tones. M.V.K.

Adherence of enamel to sheet iron. K. MEURES AND E. ZSCHIMMER. *Sprechsaal*, **65** [4], 63–64; [5], 83–85; [6], 98–100; [7], 119–21; [8], 138–39 (1932).—An iron sheet enamel having a composition of SiO_2 55.16%, B_2O_3 14.46%, TiO_2 0.22%, Al_2O_3 5.89%, Fe_2O_3 0.22%, Na_2O 13.76%, K_2O 5.80%, MgO 0.01%, and CaO 4.48% and dried at 200° was fired on sheet iron with 0.01% Si, 0.38% Mn, 0.14% P, and 0.058% S. The method used is described in detail and the grain size of the frit is given. After $3^1/_2$ years the enamel coat was investigated with the following results: (1) The surface layer of the enamel was much harder than the enamel layers near the sheet iron. (2) All the different enamel layers were analyzed and it was found that large quantities of iron oxide migrated from the sheet iron into the nearest enamel layers. (3) The enameling of sheet iron with a ground enamel is not a pure physical process for a chemical process takes place at the same time. Iron oxide formed on the surface of the sheet iron during firing penetrates into the liquid glass layer and combines chemically with its substance during the short two-minute firing. (4) The calculated analyses seem to show a loss of Na_2O and K_2O, while boric acid, alumina, and lime do not diminish markedly. (5) The separate enamel layers were determined and the penetration of Fe_2O_3 and FeO into the enamel layers was ascertained. M.V.K.

Cast iron for enameling. J. S. HANSEN. *Sheet Metal Ind.* [London], **5** [1], 2; [2], 97 (1931); *Emaillewaren-Ind.*, **9** [8], 57–58 (1932).—H. discusses the preparation of casts for enameling. M.V.K.

Making enameled castings. P. A. KOSSOVSKI AND V. LOKSCHIN. *Vestn. Metallopromychl.*, **11** [1], 117–25 (1931); *Chim. & ind.*, **26** [2], 336 (1931).—Enameling procedures are described. M.V.K.

Gas jet firing. ANON. *Emaillewaren-Ind.*, **9** [6], 40–41 (1932).—The advantages of gas firing in enamel plants are discussed and a new method of firing, the so-called "gas jet firing" is described. The gas is driven through a special burner under a pipe grate consisting of refractory pipes which withstand a temperature of 2000°. The gas runs through the pipes and washes them inside and out. The grog glowing white projects the heat accumulated in it on the muffle walls so that the heat produced is completely used up. The regulation of the temperature is made with a pyrometer. M.V.K.

Development of high-temperature electric furnaces. F. G. GONNOR. *Metal Ind.* [London], **39** [23], 542 (1931).—Until recently the only electric resistance material available for commercial use at temperatures of 1100 to 1350°C was a recrystallized silicon carbide in the form of rods. These rods have metallized terminal connections with air- or water-cooled clamps. At high temperatures they cause a certain amount of inconvenience, but the greatest disadvantage is the continually changing resistance of the silicon carbide. A new alloy for use at high temperatures was recently produced. It has a melting point over 1600° and is practically nonoxidizable at 1350°. M.V.K.

Use of metals in firing processes of vitreous enamelware. CLYDE E. WILLIAMS. *Ceram. Ind.*, **18** [3], 179–80 (1932).—Compositions of some alloys tested and in use are given together with some examples of their durability. W.W.M.

"Porcelite" wall tile is new steel base tile. COLUMBIAN ENAMELING & STAMPING CO. *Ceram. Ind.*, **18** [3], 196 (1932).—"Porcelite" is a complete insulated wall within itself. Its base consists of a heavy clip board treated to be water- and warp-proof. It is offered in many colors and can be placed over practically any type of wall. W.W.M.

Checking efficiency in enamel shop. ANON. *Ceram. Ind.*, **18** [3], 173 (1932).—By proper inventories and accurate figures on the square feet of enameled sheet iron and pounds of enameled cast iron produced it is possible to check closely the efficiency of the shop and determine any source of loss. W.W.M.

Simple system of paying enamel workers. SEEGER REFRIGERATOR CO. *Ceram. Ind.*, **18** [3], 181–83 (1932).—The porcelain department has been divided into six groups of workers and some of these groups have had increases in pay, but rework is done on the workers' time, thus creating an incentive for quality work. Several interesting mechanical features of the plant are described. W.W.M.

BOOK

Enameling Cast-Iron Bathtubs. (Das Emaillieren gusseiserner Badewannen.) L. VIELHABER. Verlag Emaillewaren-Ind., Duisburg, 1931. 1.20 Rm. Reviewed in *Glastech. Ber.*, **10** [1], 59 (1932).—V. describes (1) the manufacture of cast iron for bathtubs in the foundry, (2) the technique of powdering and implements required for it, (3) the synthesis and composition of enamels required, (4) limiting values for ground and powder enamels, and (5) the influence of different components on the physical properties of the enamel. The booklet will be valuable to all enamelists as little is known about the enameling of cast bathtubs. See also *Ceram. Abs.*, **11** [1], 12 (1932). M.V.K.

PATENTS

Enameling composition. MAHLON E. MANSON. U. S. 1,844,670, Feb. 9, 1932. An enameling composition for resisting ordinary acids consisting of approximately 68 parts of sodium silicate containing substantially 23% soda and 74% silica, 5 parts of aluminum hydrate, 13 parts of borax, 12 parts of sodium antimonate, 6 parts of cryolite, and 8 parts of barium carbonate.

Gas range. WALTER E. KIRBY. U. S. 1,844,768, Feb. 9, 1932.

Tile construction. FRANCIS ARTHUR CLOSE. U. S. 1,845,482, Feb. 16, 1932.

Tiled wall, etc. GEORGE D. HAINES. U. S. 18,376, March 8, 1932 (reissue).

Producing enamels. CHARLES J. KINZIE. U. S. 1,848,567, March 8, 1932. In the process of producing opaque enamel frits, the step which consists in adding to the enamel-forming ingredients in the raw batch and before smelting, zirconium silicate in such amount that upon subsequent smelting the zirconium and silicon in the zirconium silicate will decompose and yield about 15% zirconium oxide to combine with the ingredients to form an opaque enamel frit.

White opaque glazes and enamels. I. KREIDL. Brit. 364,529 and 364,554, Jan. 20, 1932.

Removing vitreous enamel from metal articles. W. J. TENNANT. Brit. 365,425, Jan. 27, 1932.

Glass

Pyrolusite as colorizer and decolorizer for glass. LUDWIG SPRINGER. *Glashütte*, **61** [34], 613–16 (1931); *Glastech. Ber.*, **10** [2], 90–91 (1932).—Samples of melts were prepared and compared to test the decolorizing power of manganese. Iron was introduced as ferrosoferric oxide, and manganese as 85% pyrolusite, manganese vitriol, permanga-

nate, or manganese carbonate. *Melt 1:* (*a*) ground glass for comparison (70 sand, 14.3 limestone, 30.8 soda), weak blue-green; (*b*) ground glass with 2 ferrosoferric oxide and 2 pyrolusite, smoke brown; (*c*) ground glass with 2 ferrosoferric oxide and 7 manganese vitriol, dirty yellow-green. Sample *c* was more oxidized than sample *b*. *Melt 2:* (*a*) 2 ferrosoferric oxide and 4 pyrolusite, strongly yellow-brown; (*b*) 2 ferrosoferric oxide and 14 manganese vitriol, strong yellow-brown with numerous gall deposits; (*c*) 1 ferrosoferric oxide and 2 pyrolusite, green; (*d*) 1 ferrosoferric oxide and 7 manganese vitriol, yellow-green. *Melt 3:* (*a*) 0.2 ferrosoferric oxide, strong blue-green; (*b*) 0.2 pyrolusite, weak yellowish-green; (*c*) 0.2 iron oxide and 0.2 pyrolusite, almost colorless. *Melt 4:* (*a*) 0.4 pyrolusite, weak violet; (*b*) 0.2 ferrosoferric oxide and 0.4 pyrolusite, weak green-yellow; (*c*) 0.4 ferrosoferric oxide and 0.4 pyrolusite, yellow-green. *Melt 5:* (*a*) 1 pyrolusite, strongly violet; (*b*) 1.3 manganese carbonate, yellow-green; (*c*) 1 pyrolusite and 2 potassium nitrate, strongly violet; (*d*) 1 pyrolusite and 1 arsenic, weak green-yellow; (*e*) 1.3 manganese carbonate and 2 potassium nitrate, strong violet; (*f*) 0.3 manganese carbonate and 1 arsenic, green-yellow. *Melt 6:* (*a*) 0.4 ferrosoferric oxide and 0.4 pyrolusite, yellow-green; (*b*) 0.4 ferrosoferric oxide and 0.53 manganese carbonate, blue-green; (*c*) 0.4 ferrosoferric oxide and 0.6 pyrolusite, more yellow than *6a;* (*d*) 0.4 ferrosoferric oxide and 0.8 manganese carbonate, greenish blue. *Melt 7:* (*a*) 0.1 ferrosoferric oxide and 0.1 pyrolusite, almost pure blue; (*b*) 0.1 ferrosoferric oxide and 0.2 pyrolusite, decolorized well, very weak yellow-green; (*c*) 1.45 potassium permanganate, strong violet; (*d*) 0.1 ferrosoferric oxide and 0.145 potassium permanganate, decolorized well, some bluish green; (*e*) 0.1 ferrosoferric oxide and 0.29 potassium permanganate, decolorized well, but not overcolored. *Melt 8:* (*a*) 0.1 ferrosoferric oxide and 0.4 pyrolusite, bluish green; (*b*) 0.1 ferrosoferric oxide and 0.58 potassium permanganate, pure green; (*c*) 0.1 ferrosoferric oxide and 0.7 pyrolusite, violet; (*d*) 0.1 ferrosoferric oxide and 1.0 potassium permanganate, well decolorized, but not overcolored. *Melt 9:* (*a*) 1 ferrosoferric oxide and 0.1 pyrolusite, rather blue-green; (*b*) 0.1 ferrosoferric oxide and 0.2 pyrolusite, strong blue-green; (*c*) 0.1 ferrosoferric oxide and 0.4 pyrolusite, in some degree decolorized well. *Melt 10:* (*a*) as *9a* and with 3 potassium nitrate, decolorized well, light green; (*b*) as *9b* and with 3 potassium nitrate, lighter than *a;* (*c*) as *9c* with 3 potassium nitrate, some lighter. It seems that in decolorizing with pyrolusite an optimum of the addition exists below which and over which the iron coloring appears as green, and that with comparatively large amounts of pyrolusite an overcoloring into brown or violet occurs. Pyrolusite should be considered as a good decolorizer from these tests. According to S., the researches should be continued. M.V.K.

Influence of cerium and arsenic on the photochemical behavior of silica glasses. F. ECKERT AND K. SCHMIDT. *Glastech. Ber.*, **10** [2], 80–85 (1932).—(1) The intensity of discoloration of cerium glasses in ultra-violet light depends on the cerium content. An optimum and maximum discoloration of the glass was obtained with 2.56% Ce_2O_3 after 2 hours of exposure to ultra-violet rays. The intensity and velocity of discoloration decrease with a lowering of the cerium content and are almost imperceptible with 0.005% Ce_2O_3. The color of the exposed glasses is from yellow to yellow-brown. (2) The time of exposure of glasses prepared from ordinary raw materials and melted in a blast furnace is less than that of glasses prepared from pure raw materials melted in an electric kiln for obtaining the same discoloration. (3) In an alkali-lime glass containing cerium, saltpeter does not discolor in ultra-violet light but arsenic does. When saltpeter is used in the presence of arsenic, the discoloration is accelerated. Na_2SO_4, $Na_2SO_4 + NaNO_3$, NaCl, and B_2O_3 do not discolor without arsenic. (4) Antimony, bismuth oxide, and vanadium oxide produce a discoloration equal to that of arsenic in the presence of cerium. Their elements belong to the same group of the periodic system, but the velocity and intensity of discoloration decrease with increased atomic weight. (5) As_2O_3 and Bi_2O_3.

without additions of cerium, affect the discoloration in ultra-violet light also, although the velocity and intensity of discoloration are lower than when cerium is present. A discoloration appears when using chemically pure as well as technical raw, materials. (6) Glasses with praseodymium oxide or neodymium oxide, without cerium but with an arsenic content, discolor in ultra-violet light somewhat slower than the corresponding cerium glasses. No discoloration appears in the presence of As_2O_3. (7) An addition of TiO_2 to As_2O_3–Ce_2O_3 glasses doubles the velocity of discoloration. No discoloration appears in titanium–cerium glasses in the absence of As_2O_3. (8) A glass melted in a reduced atmosphere does not discolor toward yellow in ultra-violet light, but its blue-green coloring changes to colorless. (9) A glass melted in an oxidized atmosphere discolors toward yellow and its velocity of discoloration is increased fivefold. (10) By reduction in hydrogen atmosphere and a softening temperature, the glasses show the following changes: Glasses containing arsenic color into brown and those containing antimony, into gray-brown. The proper green and blue-green color tones of all other glasses, whether containing cerium or not, change into a yellow-green and light green-yellow coloring. The cerium content seems to exert no influence on the change of the color of the glass. All these glasses do not change through exposure to ultra-violet light. (11) By oxidation in an oxygen atmosphere at softening temperature, these glasses change their green color into light yellow and yellow. They are discolored when exposed to ultra-violet light. (12) The intensity of fluorescence of cerium glasses depends on their cerium content. Phosphorescence was determinable only in glasses containing arsenic. Thermoluminescence was observed in all glasses. M.V.K.

Properties of glasses diffusing light. I. Definition and classification. L. BLOCH AND M. PIRANI. *Trav. compt. rend. séances commission internat. Éclairage*, pp. 982–84 (1931); *Glastech. Ber.*, **10** [2], 96 (1932).—Glasses diffusing light can be classified into 2 main groups, (1) mat glasses and (2) opaque glasses: (*a*) ornamental glass and (*b*) matted opaque glass. Definitions referring to permeability, reflection, absorption, and diffusion of light are given. The direct permeability of a diffusing glass goes from the source of light itself; the diffused permeability, from the diffusing glass. The same is true for the reflection. The "Ulbricht globe" is the best method for measuring the permeability, reflection, and absorption; slight direct permeability can be measured with a spectrum photometer. The curves of the diffusion of light of a diffusing glass illuminated by a perpendicularly falling light can be determined with a photometer by measuring the power of light or with an optical pyrometer by measuring the density of light. Several methods for approximate measurements of the permeability and reflection are discussed. Two special measuring apparatus for investigating illuminating glass are described, and the latest literature on the optical properties of light-diffusing glass is compiled. M.V.K.

Solubility of glasses in water in relation to their composition. I, II, III. S. MORIYASU. *Jour. Soc. Chem. Ind.* [Japan], **34** [9], 314–17*B*; [10], 358–61*B* (1931).—By using glass grains of 0.25 and 0.40 mm. diameter heated in H_2O for 1 hr. at 99° followed by conductometric titration in the powder method for determining the solubility of lead glass, the results were found to agree fairly well with those obtained by Knapp's formula (for abstract see *Ceram. Abs.*, **6** [3], 97 (1927)). The solubility in water of soda-lime-silica glass containing 3 to 17% CaO and 65 to 75% SiO_2 was determined by the powder method and the results are expressed in "isokals." The results of M. for the solubility of soda-lime-silica glasses in water are compared with those of G. Keppeler and H. Ippach (for abstract see *ibid.*, **6** [12], 569 (1927)) for the purpose of obtaining a general rule for the relation between the total loss and the alkali extracted in water and the composition. See also *ibid.*, **10** [12], 832 (1931). M.V.K.

Glasses permeable to ultra-violet rays. I. I. KITAIGORODSKI. *Ceramics & Glass*, **5**

[10], 370–75 (1929); *Glastech. Ber.*, **10** [2], 97–98 (1932).—K. discusses the properties of different glasses permeable to ultra-violet rays and describes researches made in Russia to produce such glasses. These glasses had to be highly permeable to ultra-violet rays, produced in tanks, contain more than 15% iron, and at the same time be stable and cheap. The researches showed that with a suitable mixing proportion of ingredients, glasses of an elementary composition could be obtained and although containing from 0.1 to 0.2 Fe_2O_3, they were highly permeable to ultra-violet rays. The exact composition of the glasses is not given. A permeability equal to 90% was obtained and the glasses were stable and inexpensively produced. The spectrograms given show their permeability. M.V.K.

New light-source for absorption measurements of glasses in the blue and ultra-violet. W. M. COHN. *Physik. Z.*, **32** [14], 559–61 (1931); see *Ceram. Abs.*, **11** [3], 169 (1932). W.M.C.

Volatilization of fluorine during melting of glass. I. I. KITAIGORODSKI AND S. M. KUROVSKAYA. *Ceramics & Glass*, **7** [11–12], 43 (1931).—The possible causes of volatilization of fluorine are (1) the formation of SiF_4, (2) the volatilization in the form of molecular fluorine, (3) the sublimation of undecomposed fluorides, and (4) the formation and evaporation of hydrofluoric acid. The results of the work of Edge and Krauss and that of the authors show that (1) the loss in fluorine is only a fraction of its initial quantity and (2) the loss must be ascribed to the volatilization either of the hydrofluoric acid, formed during melting of the glass, or of the molecular fluorine. M.V.K.

Boron in the glass industry. ANON. *Glass*, **8** [6], 228–29 (1931).—The advantages of adding B_2O_3 to glass are outlined under the following headings: (1) tensile strength, (2) elasticity, (3) hardness, (4) thermal expansion, (5) viscosity, (6) durability, and (7) chemical properties. Glasses containing a high percentage (2 to 20%) of B_2O_3, and those containing 0.2 to 2.0% B_2O_3 are discussed. G.R.S.

Theories of the constitution of glass. I. ANON. *Rev. belge ind. verrières*, **2**, 125–26 (1931).—Tammann's theory of glasses as supercooled liquids and Eckert's theory of a solution of complex silicates are explained. **II.** *Ibid.*, **2**, 147–48 (1931).—Bercer's theory of the three states of glass (fluid, viscous, and brittle) is discussed. Glass is also treated as a solid solution. **III.** *Ibid.*, **2**, 172–73 (1931).—Bary's theory of the colloidal nature of glass and Turner's theory of the complex nature of glass are explained. A.J.M.

Fundamentals in glass technology. V. Chromatism. C. D. SPENCER. *Ceram. Ind.*, **18** [3], 184–87 (1932).—S. touches on the optical properties of crown and flint glasses, especially their light-dispersion properties, defines the terms achromatic and apochromatic, and tells how lenses of these types are made. Absorption and reflection are discussed and three types of opalescent glass are described. Selective absorption and subtractive decoloration are also treated. The various coloring agents and colors produced by them are given. Ways of producing color in glass are (1) direct color, oxide and powdered glass melted directly with the batch; (2) reheating color, colors produced during the reheating (also incorrectly called tempering) of glass, such as gold red, copper red, selenium red, sulphur yellow, and silver yellow; and (3) Lasur or coating coloring, *i.e.*, the coloring substance, mixed with an indifferent, infusible body which will not be attacked by a soft glass is spread on the glass article which is then exposed to a muffle fire. The production of good colors with several of the commoner coloring agents is discussed. For part IV see *Ceram. Abs.*, **11** [4], 234 (1932). W.W.M.

Dependence of the properties of glass on its thermal history. E. BERGER. *Z. Instrumentenk.*, **51**, 127–36 (1931); *Sprechsaal*, **65** [8], 144 (1932); for abstract see *Ceram. Abs.*, **10** [5], 335 (1931). M.V.K.

Theoretical calculation of the influence of fills on glass and its composition. H.

JEBSEN-MARWEDEL. *Sprechsaal*, **65** [3], 44–45 (1932).—J. discusses the work of James Bailey (for abstract see *Ceram. Abs.*, **10** [11], 762 (1931)) on the question "How many times is glass melted?" M.V.K.

Determining the annealing temperature of eleolite glass. A. I. ZHILIN. *Ceramics & Glass*, **7** [11–12], 44–45 (1931).—The method used for determining the annealing temperature consisted in observing the strains of the samples heated in polarized light with the help of Endel's heating microscope. The samples had the form of small cylinders about 100 mm. long. The rate of heating ranged from 4.0 to 6.9° per min. See also *Ceram. Abs.*, **11** [4], 232 (1932). M.V.K.

Specific heat of bottle glass. H. E. SCHWIETE AND H. WAGNER. *Glastech. Ber.*, **10** [1], 26–30 (1932).—The authors discuss (1) the significance of specific heats of glasses for the glass industry, (2) known values, (3) real and mean specific heat, and (4) measurements of the mean specific heat of three bottle glasses including methods used, apparatus, and substances investigated. M.V.K.

Endothermic effect in the softening range of silica glasses. F. ECKERT AND I. WESTERMANN. *Glastech. Ber.*, **10** [1], 30–37 (1932).—The authors discuss (1) the properties of glasses in the softening range, (2) detection and significance of the endothermic effect according to Tool, (3) new theory of the endothermic effect, and (4) researches on the influence of the melting temperature, melting time, raw materials, and glass composition on the endothermic effect. M.V.K.

Alkali-lime-silica glasses. G. KEPPELER AND K. BÖHMERT. *Keram. Rund.*, **38**, 663–66, 697–700, 711–13, 738–42, 787–88 (1930); *Chem. Zentr.*, **i**, 1341 (1931).—Devitrification limits, melting point, specific gravity, and extraction values of K glasses were determined. For similar molecular composition Na glasses are better. Except with glasses high in K or Ca, for similar weight composition K glasses are better. Na-K-Ca-SiO_2 glasses showed no extraction minimum contrary to Peddle's result which is attributed to devitrification. (*B.C.A.*)

Durability of glasses containing alkalis and lime. OSCAR KNAPP. *Keram. Rund.*, **39** [9], 124–26 (1931); *Chim. & ind.*, **26** [3], 632 (1931).—K. discusses the difference between similar glasses having a soda and potash base in their resistance to corrosion. He also discusses the researches of Berger made on a series of glasses in some of which soda only was used while in others soda was replaced by potash. The method of Mylius was used. The results show that the resistance to corrosion of potash glass is double that of soda glass. On the other hand, the molecular percentage of the resistance to corrosion of both glasses is the same. M.V.K.

Viscosity measurements in molten glass. H. R. LILLIE. *Jour. Rheol.*, **3** [1], 121–26 (1932).—The relations existing between viscosity determinations and the various stages of glass manufacture are pointed out and explained with reference to a typical viscosity-temperature curve. The rotation viscometer employed in making such determinations is described. Curves are shown for four representative types of glasses: lead, lime, lead borosilicate, and hard borosilicate. The use to which such comparison curves may be put is indicated. See also *Ceram. Abs.*, **10** [8], 552 (1931). G.R.S.

Absorption measurements of several glasses by means of the thorium and uviol lamps and the continuous hydrogen spectrum. W. M. COHN AND C. ANDRESEN-KRAFT. *Z. tech. Physik*, **12** [9], 428–33 (1931).—Several advantages of the new thorium lamp in comparison with the hitherto known light sources were found from absorption measurements of some ferric and ferrous glasses. Microphotometer curves of spectra are given for absorption measurements by means of the different light sources compared. W.M.C.

Tests for glassware. J. B. MURGATROYD. *Glass*, **8** [7], 272–77 (1931).—The

following tests are discussed: (1) impact, (2) temperature shock, (3) internal pressure, (4) glass composition and strength, (5) inhomogeneity and strength, (6) surface condition and strength, and (7) shape of glassware and its strength. G.R.S.

Surface durability of glassware. W. E. S. TURNER AND VIOLET DIMBLEBY. *Pottery Gaz.*, **57** [656], 240–41 (1932).—Considerable work has been done in an endeavor to standardize some method of testing surface durability of glassware, the final choice involving the boiling of water in the bottles under test for six hours, and afterward determining the amount of alkali extracted thereby. Details of conducting the test are given and some of the results obtained are discussed. E.J.V.

Properties of the surface of glass. I. V. GREBENSHCHIKOV. *Ceramics & Glass*, **7** [11–12], 36–41 (1931).—G. reviews the world literature devoted to the physical and chemical properties of the glass surface and gives proofs of the existence of a film of colloidal silica on the surface of glass. The presence of this film explains the chemical stability of glass, the phenomenon of adsorption, coefficient of light reflection, etc. The chemical reactions taking place on the surface of glass during the process of cutting, grinding, and polishing are described. M.V.K.

Dependence of the alkalinity of glass surfaces on the temperature. G. KEPPELER AND M. HECKTER. *Glastech. Ber.*, **10** [1], 37–40 (1932).—The heating of several glass tubes of the same kind to 450, 500, 550, and 575° for 1, 2, 4, and 7 hr. showed that with rising temperature and increased heating time, an increase of the alkalinity defined by Mylius appears. The researches show that owing to the temperature, the surfaces strive against a definite equilibrium. The velocity with which the enrichment of alkalinity at higher temperatures occurs on the surface of the glass can increase the neutralizing action of cooling gases and make ineffective a chemical improvement of the glass surface. M.V.K.

Effect of the alumina content of glass on the degree of corrosion of the grog materials of the glass furnace. P. P. BUDNIKOFF, G. W. KUKOLEV, AND I. S. SMELJANSKY. *Feuerfest*, **7** [6], 92 (1931); for abstract see *Ceram. Abs.*, **11** [2], 87 (1932). M.V.K.

Weather stability of glasses. HUGO HERMANN. *Sprechsaal*, **65** [3], 45–46 (1932).—H. discusses the deterioration of glassware during transportation and the little attention paid to this fact by glass manufacturers. The methods used at present, *e.g.*, (1) treating the glass surface with fire gases to make it more resistant, (2) washing the surface of the glass with dilute acids, (3) covering the glass surface with a protective layer of vaseline, and (4) special kinds of packing which do not give adequate results, are discussed. M.V.K.

Index of refraction for X-rays in several glasses. F. JENTZSCH AND E. NAEHRING. *Z. tech. Physik*, **12** [9], 424–28 (1931).—The index of refraction of fifteen glasses used for optical purposes was determined for the wave-length $X = 1.54$ Å. Photographic and ionometric methods were used. The values determined agree for only two glasses with the theoretical values. With all other glasses deviations were found, the average being 43% and the maximum deviation 66%. W.M.C.

New auxiliary lens increases power of reflecting telescopes. ANON. *Amer. Glass Rev.*, **51** [16], 10 (1932).—One of the chief disadvantages of the reflecting or mirror type of astronomical telescope, as compared with the refractor in which a lens focuses the rays of starlight, has been overcome by a new auxiliary lens invented by F. E. Ross of the Yerkes Observatory. In a paper presented at the meeting of the American Astronomical Soc. in Washington in December, the improvements resulting from the use of this lens were shown. It was also announced that the Ross lens will be applied to the 200-in. reflecting telescope being constructed for the Calif. Inst. of Technology. R. tested his lens on the 60-in. telescope of the Mount Wilson Observatory. The lens of a refractory telescope can only be supported around the edge, and this limits its size, but

the concave mirror of a refractory may be supported all over its back. Thus the mirrors may be made larger without any danger of the bending of the glass affecting their shape, but the reflector cannot focus sharply over a large area of sky. See also *Ceram. Abs.*, **9** [12], 1038 (1930); **10** [10], 734 (1931). E.P.R.

Safety glass. A. BRESSER. *Sprechsaal*, **65** [4], 61–62 (1932).—B. discusses the following organic polymerizable compounds used in the manufacture of safety glass: (1) polymerizable ester of acrylic acid, (2) ester of cinnamic acid or crotonic acid, (3) polymerized stryol in different stages of polymerization, (4) polyvinyl compounds alone or in combination with other substances such as a mixture of polyvinyl acetate and ester of acrylic acid, (5) rubber in the form of a thickly liquid solution (a good adhesive substance), (6) artificial resins as products of concentrated phenolformaldehyde, (7) albumin, (8) fish glue, (9) nitrocellulose mixture without camphor, (10) cellulose derivative, (11) urea and formaldehyde resin, and (12) toluene-sulphonamidaldehyde resins. A short description of ways in which these substances are used is given. M.V.K.

Unsplinterable glass. W. SCHLITT. *Glass*, **8** [10], 412 (1931).—A description is given of various methods of forming compound glass sheets with intermediate elastic transparent media such as celluloid and gelatin. G.R.S.

Glazing glass pots according to the method of Scholes. M. F. SHUR AND P. W. WASSILJEV. *Glashütte*, **61** [50], 913–14 (1931); *Feuerfest*, **8** [1], 15 (1932).—The authors describe a method of coating glass pots with a special cement to protect them from the disintegrating action of the batch and melted glass. M.V.K.

Horizontal drawing of pane glass. ANON. *Glashütte*, **61** [23], 420–21 (1931); *Glastech. Ber.*, **10** [2], 91 (1932).—A description of a new method of drawing glass panes according to the patents of Brauer-Greiner is given. M.V.K.

Severing glass. R. E. SWAIN. *Glass Ind.*, **13** [3], 39–41 (1932).—Heavy household shears are used to centralize the stream of glass and to shorten the shearmark. The different methods used in removing the mold-blown ware from the pipe, burning off with a fine pointed flame, cutting off by means of a hot electric wire, cutting tubular articles with a soft iron wire on rapidly rotating glass, the use of a soft steel disk having a peripheral speed of about 7000 ft./min., and the use of fine grinding wheels are some of the methods discussed. The finishing operations after severing are described. E.J.V.

Separating glass into layers during cooling. SHVETZOV. *Bull. Acad. Sci.* [U.S.S.R.], pp. 1141–50 (1931).—S. describes researches made on 9 glasses of different compositions which were ground and then subjected to repeated melting. It was found that the specific gravity and chemical composition differed greatly in the upper and lower parts of the glass masses. S. assumes that this fact proves that glass separates into layers during slow cooling. M.V.K.

Continuous motion gob-fed glass machine. WHITALL TATUM CO. *Ceram. Ind.*, **18** [3], 200–203 (1932).—A description of the new Hartford machine, designed for high production of bottles, 12 ounces and lower, and having a built-in cooling system, is given. W.W.M.

Electric continuous annealing furnace. ANON. *Metal Ind.* [London], **39** [24], 558 (1931).—The furnace consists of a steel tower carrying the refractory furnace lining. This vertical arrangement of the furnace has been found to have considerable advantage. The heating elements of the furnace are silicon carbide glow bars. M.V.K.

Suspended crowns. ANON. *Glass*, **8** [5], 189–91 (1931).—Advantages of flattening of the arch are (1) economy in fuel, and (2) even distribution of heat. A sprung arch built with a minimum rise necessitates (1) increased strength of buckstays and ties, (2) secure anchorage for buckstays, and (3) extremely careful supervision and control of the tensioning of ties while heating up. The flat and convex suspended crowns represent a still greater economy in fuel, better heat distribution, and abolition

of buckstays. Both types are illustrated, and the methods of suspension are described. G.R.S.

Improvement in heat economy of glassmelting tanks. W. FRIEDMANN. *Arch. Wärmewirt.*, **12** [10], 289–90 (1931). W.M.C.

Decreasing the cost of the batch. ANON. *Sprechsaal*, **65** [8], 137 (1932).—The possibilities of decreasing the costs of a glass batch by replacing the more expensive raw materials with cheaper ones, *e.g.*, a part of the potash by a certain quantity of borax in the manufacture of crystal, opal, or colored glasses, are discussed. M.V.K.

Manufacture of rolled plate. XVIII. ERNST LUTZ. *Glass Ind.*, **13** [3], 42–46 (1932).—The methods of setting large sheets of glass on the grinding tables are described, the advantage of the suction cranes for this purpose being pointed out. Some of the patents involving tipping apparatus and tables are enumerated. Considerable attention is given to the different factors which influence the maximum output possible in a grinding and polishing shop. The size of the grinding and polishing shop force as influenced by the output of polished glass per annum is calculated. Illustrated. For Part XVII see *Ceram. Abs.*, **11** [4], 236 (1932). E.J.V.

Two new types of plate glass. ANON. *Amer. Glass Rev.*, **51** [24], 22–25 (1932).—These new developments are presented under the names of "water-white" plate glass and "flesh-tinted" plate glass. "Water-white" plate glass in appearance is a pure white glass. It is colorless, both in thin section (from face to face) and in thickness (edge to edge). Research thus far has revealed its extraordinary and high quality for transmitting and reflecting all the colors of the visible spectrum. As yet, it has not been tested in the ultra-violet ray range or in those wave-lengths under 400 mμ. The "flesh-tinted" plate glass is approximately the same color as the flesh of the normal Caucasian. "Flesh-tinted" glass is used as a transmitter and reflecting agent to give the objects seen through it a warm lifelike glow. E.P.R.

Outside walls of glass. E. J. KAHN. *Amer. Glass Rev.*, **51** [23], 20 (1932).—K. describes a wall as strong as one of concrete made of glass 2 in. thick. An air space between 1-in. thick slabs of glass would prevent undue loss of heat in the building in winter. The wall could be made opaque and yet translucent, and permanently decorated by mold etchings. E.P.R.

Luminous glass architecture. WENTWORTH M. POTTER AND PHELPS MEAKER. *Ceram. Ind.*, **18** [3], 188–95 (1932).—The scope of luminous architectural elements and a discussion of properties of pertinent materials giving efficiency and brightness data are included in this paper. The use of color in luminous architectural elements is also discussed. W.W.M.

Glass silk for heat insulation. ANON. *Glass*, **8** [5], 196 (1931).—For insulation of pipe the glass silk is supplied in strip form, which is wound helically around the pipe so that each turn fits snugly against its neighbor. One inch thickness of glass silk reduces the heat loss by 20% at 800°F, and by 30% at 200°F as compared with one inch of 85% magnesia. See also *Ceram. Abs.*, **11** [1], 18 (1932). G.R.S.

Heat-resisting glass prisms used in new lighting system. A. H. SULLIVAN. *Amer. Glass Rev.*, **51** [22], 20 (1932).—A new lighting system, the units of which consist of three prisms of special heat-resisting glass which throw the light in a 170° angle, has been worked out by S. The arrangement does away with the necessity of poles and casts three separate beams which light only the roadway. E.P.R.

Meeting of the German Society of Glass Technology. ANON. *Sprechsaal*, **64** [47], 866–68 (1931).—At the meeting of the German Society of Glass Technology held in Berlin in November, the following reports were read: (1) K. J. Lamm, "Islamic glasses" (see following abstract); (2) F. Späte, "Requirements for glasses used in the electric industry" (for abstract see *Ceram. Abs.*, **11** [2], 89 (1932)); (3) H. Löffler, "Chemical

decoloration" (for abstract see *ibid.*, **11** [2], 92 (1932)); (4) W. Biltz and F. Weibke, "Calculating densities of glasses" (for abstract see *ibid.*, **11** [2], 89 (1932)); (5) B. Kind, "Working glasses with hard metal-cutting tools"; (6) H. Thümling, "Metal working with Widia tools"; (7) A. Gellhorn, "The problem of art as a new stimulator for the glass industry"; (8) G. Keppeler, "Composition and use of household glass"; (9) H. Jebsen-Marwedel, "Bubbles and streaks in the glass melt" (for abstract see *ibid.*, **11** [2], 88 (1932)); (10) Elsa Honigmann, "Processes taking place during glass matting" (for abstract see *ibid.*, **11** [2], 92 (1932)); (11) E. Albrecht, "Strength tests with mirror and machine glass" (for abstract see *ibid.*, **11** [3], 167 (1932)); (12) E. Meyer, "Sound technical properties of bottle glass" (for abstract see *ibid.*, **11** [3], 167 (1932)); and (13) K. V. Beauvais, "Working of glass molds." M.V.K.

Islamic glass. KARL JOHAN LAMM. *Glastech. Ber.*, **10** [2], 65–71 (1932).—L. gives a historical review of the glass industry in Egypt, Syria, and Mesopotamia in the Middle Ages. Methods used for producing artistic glass, cutting, polishing, engraving, coloring, gilding, and enameling glass are discussed. Illustrated. M.V.K.

Progress of the glass industry in 1931. ANON. *Glashütte*, **62** [1], 7 (1932).—The researches are discussed of Eitel (*Repts. German Engineers Czechoslovakia*, No. 10 (1930)); Oscar Knapp (*Ceram. Abs.*, **10** [10], 683 (1931)); J. W. Gill and W. C. Rueckel (*ibid.*, **10** [2], 107 (1931); and F. W. Preston (*ibid.*, **10** [7], 485 (1931)) on the structure, constituents, and properties of glasses. M.V.K.

Life at an old Bohemian glassworks. J. BÁRTA. *Sprechsaal*, **63** [37], 701; [38], 724; [39], 743; [45], 854; [50], 957; [51], 976 (1930); **64** [17], 319; [35], 649; [37], 685; [38], 704; [42], 775 (1931). W.M.C.

BOOKS

Glass Manufacture. Vols. I and II. (Die Glasfabrikation.) ROBERT DRALLE. 2d ed. R. Oldenburg, München, 1931. 719 pp. 666 illustrations. Unbound 60 Rm., bound 64 Rm. Reviewed in *Glashütte*, **61** [47], 871 (1931); *Sprechsaal*, **64** [51], 963 (1931); *Pottery Gaz.*, **57** [656], 249 (1932).—The first volume treats the principles, expedients, and methods of working in glass manufacture from all points of view. The second volume is devoted to the separate processes of glass manufacture. See also *Ceram. Abs.*, **9** [10], 873 (1930). M.V.K.

German Glass Industry. Vol. 14. (Deutsche Glasindustrie.) ANON. 227 pp. E. S. Mittler and Son, Berlin, 1931. Reviewed in *Glass*, **8** [10], 421 (1931).—This report contains information concerning all aspects of the four principal sections of the German glass industry: sheet, plate, bottles, and hollow ware. G.R.S.

Tables for Glass Technology. W. EITEL, M. PIRANI, AND K. SCHEEL. Reviewed in *Glass Ind.*, **13** [1], 4 (1932); *Glashütte*, **61** [52], 953 (1931); for review see *Ceram. Abs.*, **11** [4], 241 (1932).

Glass. HERMANN THIENE. Reviewed in *Glass*, **8** [9], 376 (1931); see also *Ceram. Abs.*, **11** [1], 19 (1932). G.R.S.

Address Book of the Glass Industry, 1931. ANON. 15th ed. Reviewed in *Glass*, **8** [9], 376 (1931); see also *Ceram. Abs.*, **11** [4], 240 (1932). G.R.S.

PATENTS

Glassware-forming machine. JOHN RALPH HOGE. U. S. 1,843,129, Feb. 2, 1932. AUGUST KADOW AND LEONARD D. SOUBIER. U. S. 1,843,165, Feb. 2, 1932. HAROLD A. ROHRICH. U. S. 1,845,626, Feb. 16, 1932.

Device for emptying glassmelting pots. MICHAEL FINCKE. U. S. 1,843,152, Feb. 2, 1932. WILHELM SPIEKERMANN. U. S. 1,843,179, Feb. 2, 1932.

Glass-blowing machine and method. HENRY W. INGLE. U. S. 1,843,159 and 1,843,160, Feb. 2, 1932.

Flowing glass. LEONARD D. SOUBIER. U. S. 1,843,178, Feb. 2, 1932.

Controlling gravity issuance of molten glass. LEONARD D. SOUBIER. U. S. 1,843,248, Feb. 2, 1932.

Glass feeder. LEONARD D. SOUBIER. U. S. 1,843,249, Feb. 2, 1932. THOMAS STENHOUSE. U. S. 1,847,276, March 1, 1932. ROBERT GOOD. U. S. 1,844,847, Feb. 9, 1932.

Composite silica article. ELIHU THOMSON. U. S. 1,843,792, Feb. 2, 1932.

Grading abrasives for use in continuous glass-grinding machines. FREDERIC BARNES WALDRON AND JAMES HARRIS GRIFFIN. U. S. 1,843,854, Feb. 2, 1932.

Drawing glass. ARTHUR E. SPINASSE. U. S. 1,844,049, Feb. 9, 1932.

Making composite glass. WILLIAM ORLAND LYTLE. U. S. 1,844,098, Feb. 9, 1932.

Annealing glassware. ROBERT GOOD. U. S. 1,844,154, Feb. 9, 1932. VERGIL MULHOLLAND. U. S. 1,846,566, Feb. 23, 1932.

Glass-forming machine. KARL SCHNEEGLUTH. U. S. 1,844,185, Feb. 9, 1932. THEODORE H. SLOAN. U. S. 1,845,525, Feb. 16, 1932.

Glassworking machine. BENJAMIN T. HEADLEY, DAVID IRVIN DU BOIS, BERNARD H. KOOB, AND FRANK H. LOBB. U. S. 1,844,549, Feb. 9, 1932.

Feeding glass. FRITZ ECKERT. U. S. 1,845,491, Feb. 16, 1932.

Feeding molten glass. LEONARD D. SOUBIER. U. S. 1,845,635, Feb. 16, 1932.

Lip tile and support therefor. JESSE W. WILDERMUTH. U. S. 1,845,642, Feb. 16, 1932.

Glassware-forming machine mold and mold carrier. FLOYD FLEXON. U. S. 1,845,654, Feb. 16, 1932.

Conducting molten glass. WALTER O. AMSLER. U. S. 1,845,824, Feb. 16, 1932.

Glass apparatus. JOHN L. DRAKE. U. S. 1,845,909, Feb. 16, 1932. JESSE W. WILDERMUTH. U. S. 1,847,156, March 1, 1932.

Glass take-off mechanism. LAMBERT VON REIS. U. S. 1,846,503, Feb. 23, 1932. The combination with a sheet glass forming machine of a series of leers located along a runway.

Drawing sheet glass. RENÉ ARCQ. U. S. 1,846,984, Feb. 23, 1932.

Producing sheet glass. DANIEL ADAMS. U. S. 1,848,097, March 8, 1932. JAMES C. BLAIR. U. S. 1,848,102, 1,848,153, and 1,848,154, March 8, 1932. JOHN L. DRAKE. U. S. 1,848,111, 1,848,112, and 1,848,114 to 1,848,116, March 8, 1932.

Sheet edge-forming device. HORACE E. ALLEN AND ENOCH T. FERNGREN. U. S. 1,848,099, March 8, 1932.

Forming and annealing sheet glass. JAMES C. BLAIR. U. S. 1,848,103, March 8, 1932. CARROLL CONE. U. S. 1,848,107 and 1,848,161, March 8, 1932. JOHN L. DRAKE. U. S. 1,848,117, March 8, 1932.

Forming sheet glass. JOHN L. DRAKE. U. S. 1,848,113, March 8, 1932.

Sheet glass apparatus. CARROLL CONE. U. S. 1,848,162, March 8, 1932.

Soundproof and heat-insulating glass. WILLARD L. MORGAN. U. S. 1,848,190, March 8, 1932.

Pneumatic glass feeder. THOMAS STENHOUSE. U. S. 1,848,395, March 8, 1932.

Molding apparatus. JOHN EMERSON. U. S. 1,848,467, March 8, 1932.

Glass beveling machine. RUDOLF FÖHRENBACH. U. S. 1,848,470, March 8, 1932.

Blowing and molding articles in silica glass. GASTON DELPECH. U. S. 1,848,940, March 8, 1932.

Combustion chamber for leers. WILLIAM T. HONISS. U. S. 1,849,037, March 8, 1932.

Stacking glassware. HENRY W. INGLE. U. S. 1,849,038, March 8, 1932.

Apparatus for fusing quartz. J. Y. JOHNSON. Brit. 364,688, Jan. 20, 1932.

Rotary glass-blowing machines. BULLMAN MACHINE CO., LTD. Brit. 364,941, Jan. 20, 1932.

Electric melting of glass. L. MELLERSH-JACKSON. Brit. 364,999, Jan. 20, 1932.

Laminated glass. O. C. HAWKES, LTD., AND B. G. T. HAWKES. Brit. 365,371, Jan. 27, 1932.

Leers, annealing furnaces, etc. CANNING TOWN GLASS WORKS, LTD., AND J. J. PARNABY. Brit. 365,248, Jan. 27, 1932.

Glass-forming apparatus. LYNCH CORP. Brit. 365,245, Jan. 27, 1932.

Machines for cleaning plates of glass. PILKINGTON BROS., LTD., AND F. E. SLOCOMBE. Brit. 365,196, Jan. 27, 1932.

Wired glass. CHANCE BROS. & CO., LTD., AND A. L. FORSTER. Brit. 365,700, Feb. 3, 1932.

Forming bottoms in glass tubes. E. ZAPPERT. Brit. 365,592, Feb. 3, 1932.

Circulating the glass in glass furnace gathering basins. J. MONCRIEFF, LTD., AND A. F. MCNISH. Brit. 365,514, Feb. 3, 1932.

Shelves, table tops, etc., made of glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE SAINT-GOBAIN, CHAUNY, ET CIREY. Brit. 366,104, Feb. 10, 1932.

Glassmelting furnaces. HARTFORD-EMPIRE CO. Brit. 366,530, Feb. 17, 1932.

Cementing composition for use in preparing laminated material. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 366,889, Feb. 17, 1932.

Treatment of the felts employed for polishing glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE SAINT-GOBAIN, CHAUNY, ET CIREY. Brit. 366,872, Feb. 17, 1932.

Slabs or molded blocks made of glass to be employed as building materials. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE SAINT-GOBAIN, CHAUNY, ET CIREY. Brit. 366,476, Feb. 17, 1932.

Composite glass sheets. FORD MOTOR CO., LTD. Brit. 365,828, Feb. 3, 1932.

Structural Clay Products

Effect of de-airing on the strength of stiff-mud products in the wet state. ELLIS LOVEJOY. *Jour. Amer. Ceram. Soc.*, **15** [4], 231–33 (1932).

Use of natural gas in firing structural clay products. MARION W. BLAIR. *Jour. Amer. Ceram. Soc.*, **15** [4], 261–63 (1932).

Report of Committee C-10 on hollow masonry building units. *Proc. A.S.T.M.*, **31** [Part I], 430–35 (1931).—Committee C-10 recommended immediate revision of the standard specifications for hollow burned-clay load-bearing wall tile and fireproofing partition and furring tile, which consisted in deleting the requirements pertaining to fire resistance and a change in the designation of hollow-clay building units by substituting the words "structural clay tile" for the expression "hollow burned-clay tile" or "hollow tile." R.A.H.

Report of Committee C-3 on brick. *Proc. A.S.T.M.*, **31** [Part I], 303–304 (1931).—Committee C-3 on brick approved the advancement to standard of the tentative methods of testing brick. The problem of resistance to weathering has engaged the attention of the committee for the past year and laboratory investigations are being carried out. A review of the knowledge of weathering of structural clay products was contributed by J. W. McBurney (for abstract see *Ceram. Abs.*, **11** [3], 175 (1932)) as part of the sym-

posium on weathering characteristics of masonry materials. A bibliography on the weathering of structural clay products was also compiled by D. E. Parsons (for abstract see *ibid.*, **11** [3], 176 (1932)). R.A.H.

Fundamentals and economies in the clay industries. XIII. ELLIS LOVEJOY. *Clay-Worker*, **97** [2], 78–80 (1932).—Several processes and devices for removing pebbles from clays are described. A rotary drier and subsequent dry-pan pulverization is the most effective method. Troubles encountered in the use of pebbly clays are discussed. Tough plastic clays, which include the gumbo and other excessively plastic sticky alluvial clays, some of the shales of the Tertiary period, and some Cretaceous shales, also present considerable trouble largely because of difficulty in drying. Various methods of handling these clays are discussed. Humidity drying for all ware made of such clays is recommended. For Part XII see *Ceram. Abs.*, **11** [4], 244 (1932). E.J.V.

Firing of bituminous clays for brick. ANON. *Tonind.-Ztg.*, **56** [7], 92–93 (1932).—To diminish the plasticity of bituminous clays, the substances used, as well as the necessity of a slow rate of heating before the clay surface becomes sintered, are emphasized. W.M.C.

Evaporation of water in brick and the formation of efflorescence. ANON. *Corriere Ceram.*, **13** [1], 23 (1932).—Drying tests were made under the same conditions on 3 types of brick having a porosity of 40, 31, and 16%, respectively. In the sample of 40% porosity evaporation was uniform during 20 hr.; in the others, the velocity of evaporation scarcely diminished after 1 hr. In the first case, the soluble salts came to the surface and were separated in the form of visible efflorescences. In the second, the salts remained in the mass of the brick and produced the hidden efflorescences under the surface which tend to produce bursting. The formation of efflorescence in masonry varies according to whether the suction produced by the mortar is greater or less than that of the brick. The principal cause of the deterioration of brick is the crystallization of the soluble salts. M.V.K.

Improved soaking test. H. HIRSCH. *Tonind.-Ztg.*, **56** [11], 150 (1932).—To test the content of soluble salts in a brick, a bottle of distilled water is placed on the brick with the opening down. After soaking, the brick is dried bringing the salts to the surface. If it is difficult to identify the salts one-half of the brick may be fired, making the soluble salts readily distinguishable. Illustrated. W.M.C.

Large grinders improve quality. ANON. *Brick Clay Rec.*, **80** [2], 100 (1932).—By installing 14-in. muller-equipped grinders instead of granulator rolls for grinding its clay, the Rockford (Iowa) Brick & Tile Co. reduced the absorption from 12 to 3.59% and increased the load-bearing strength from 1550 to 2200 lb. per sq. ft. A by-product is a mortar mix of ground shale without lime. Data comparing this material and lime-cement mortars are presented. E.J.V.

Reinforced brick bridge built without falsework. ANON. *Brick Clay Rec.*, **80** [2], 86–87 (1932); *Clay-Worker*, **97** [2], 81–83 (1932).—A 42-ft. span bridge of reinforced brick masonry successfully carries 2-ton tractors or a load of 80 lb. per sq. ft. The construction details are discussed. Illustrated. E.J.V.

Manufacture of drain pipe. ANON. *Tonind.-Ztg.*, **56** [10], 133–35 (1932).—The requirements for drain pipe and their manufacture are described. Illustrated. W.M.C.

Brick and lime in agriculture. ANON. *Tonind.-Ztg.*, **56** [10], 131–33 (1932).—The manufacture of brick and lime in connection with agriculture and the use of brick and lime for agricultural purposes are discussed. W.M.C.

Costs of manufacture in brick plants. K. UFERMANN. *Tonind.-Ztg.*, **56** [15], 210–11 (1932).—Different types of costs encountered in a brick plant are discussed. W.M.C.

Westmold face brick. ANON. *Brick Clay Rec.*, **80** [2], 88 (1932); for abstract see *Ceram. Abs.*, **11** [4], 245 (1932). E.J.V.

Brick apartments. ISADORE ROSENFIELD. *Arch. Forum* [Part II], **56** [2], 183–87 (1932).—Brick was used almost entirely throughout the Phipps Garden Apartments. In the stairwells of the walk-up unit salt-glazed brick were used. E.P.R.

Uses of brick. MILES RATHMELL. *Brit. Clayworker*, **40** [478], 396–98 (1932).—R. considers possibilities that might appeal to the architect and gives the historical development of brickwork and a review of its 20th Century uses. R.A.H.

New type of brick wall construction. ANON. *Brick Clay Rec.*, **80** [2], 89–90 (1932).—The Common Brick Manufacturers Assn. Dubl-Wall developed by Clarence Seavers and the wall by A. H. Farrens use a newly developed unit which is described. Illustrated. E.J.V.

Rebuilding a plant for greater profits. H. C. KENYON. *Brick Clay Rec.*, **80** [2], 97–100 (1932).—The Standard Brick & Supply Co. has rebuilt its plant and obtained greater efficiency, reduced cost, and less labor. Illustrated. E.J.V.

National Paving Brick Assn. meeting. ANON. *Brick Clay Rec.*, **80** [2], 92–96 (1932); *Clay-Worker*, **97** [2], 98–99 (1932).—With over a 100% increase in membership and operating on a sound business basis, the Paving Brick convention discussed resurfacing, gas tax, fillers, and other problems. Brief summaries of the papers are given. E.J.V.

National Brick Manufacturers Research Foundation discusses reinforced brickwork. ANON. *Brick Clay Rec.*, **80** [2], 104–105 (1932); *Clay-Worker*, **97** [2], 96–97 (1932).—Summaries of reports are given. Illustrated. E.J.V.

Common brick for mass masonry and home construction. ANON. *Brick Clay Rec.*, **80** [2], 82–85 (1932); *Clay-Worker*, **97** [2], 84–87 (1932).—The Common Brick Manufacturers Assn. stresses the importance of reinforced brickwork and intelligent selling. E.J.V.

Brick production vs. sales. CLARENCE P. AUSTIN. *Brick Clay Rec.*, **80** [2], 101–102 (1932). E.J.V.

Recapturing the mass brickwork markets. HUGO FILIPPI. *Clay-Worker*, **97** [2], 87–91 (1932).—A ten-point plan essential to the success of reinforced brickwork is outlined. E.J.V.

Fire resistance of walls. R. SCHLYTER. *Tonind.-Ztg.*, **56** [6], 74–75 (1932).—From the book by S. on "Testing of Fire Resistance of Building Walls," Stockholm, 1931, results of fire-resistance tests are given for common brick, terra cotta, sand-lime brick, hollow cement tile, and gas concrete. W.M.C.

Trampke sand-lime brick plant. B. KRIEGER. *Tonind.-Ztg.*, **56** [13], 188–89 (1932).—This new plant in Germany operates with the so-called silo process. W.M.C.

Resistance of buildings to fire. RAGNAR GÖTHERSTRÖM. *Tegel*, **20** [1], 3–6; [2], 8–12; [3], 18–22; [4], 25–29; [5], 33–35 (1930).—G. reviews the important conflagrations that have taken place in Sweden during the past century and shows that tile construction always showed superior fire resistance. Building ordinances and fire insurance regulations are discussed. G. concludes that tile is a highly desirable structural material from the standpoint of fire resistance. H.F.V.

Arabian brick plants at Bagdad. H. KREMSKI. *Tonind.-Ztg.*, **56** [5], 62–63 (1932).—The art of brickmaking has remained the same in Mesopotamia from ancient times. Photographs show the making and firing of the brick. Brushwood is used as fuel. W.M.C.

Training of brickmakers. ANON. *Tonind.-Ztg.*, **56** [16], 228–29 (1932).—Three authors discuss the best methods of training brickmakers. W.M.C.

PATENTS

Floor and ceiling construction. GEORGE W. DENISON. U. S. 1,843,112, Feb. 2, 1932.

Building unit. EDWIN M. WYATT AND KEMPER SLIDELL. U. S. 1,843,184, Feb. 2, 1932.

Facing for wall building blocks. CLARENCE A. WILLSON. U. S. 1,844,828, Feb. 9, 1932.

Producing cellular building material. KEMPER SLIDELL AND SHERMAN Q. LEE. U. S. 1,845,350, Feb. 16, 1932.

Texturing face brick. EDWIN M. WYATT. U. S. 1,845,383, Feb. 16, 1932.

Facing clay bodies. CLAUDE B. YOUNG. U. S. 1,845,695, Feb. 16, 1932.

Manufacture of blocks, slabs, and other shaped bodies having a cellular structure. A. F. BERRY. Brit. 365,154, Jan. 27, 1932.

Conduits for drainage purposes. J. W. E. NORMAN. Brit. 365,805, Feb. 3, 1932.

Hollow flooring tile. H. ROSS, J. ROSS, AND R. H. HOMAN. Brit. 366,018, Feb. 10, 1932.

Vitrified argillaceous products. W. B. PINE, J. B. SHAW, AND M. C. SHAW. Brit 366,498, Feb. 17, 1932.

Refractories

Some properties of chrome spinel. C. W. PARMELEE AND ABDE ALLY. *Jour. Amer. Ceram. Soc.*, **15** [4], 213–25 (1932).

Extrusion of refractory oxide insulators for vacuum tubes. LOUIS NAVIAS. *Jour. Amer. Ceram. Soc.*, **15** [4], 234–51 (1932).

Report of Committee C-8 on refractories. *Proc. A.S.T.M.*, **31** [Part I], 312–21 (1931).—Committee C-8 on refractories has approved the flexure test described in the tentative methods of testing brick for use in testing refractories. Revisions have been proposed in the method of test for porosity and volume changes in refractory materials and in the test for the softening point of fireclay brick. A revision of the softening point test was also advanced to standard, and the tentative method of test for spalling action was revised. Definitions of the terms "spalling" and "pyrometric cone equivalent" were advanced to standard. A study of the abrasion of refractories at high temperature has been continued at Pennsylvania State College. The section on temperature has again made a critical study of the P.C.E. test, and it has been found that there is a necessity for still further testing work preferably on the three existing types of furnaces by one laboratory. In the study of heat transmission of refractories, the construction of a calorimeter for testing refractory insulation is in progress. A survey of furnaces used to perform the load test has been made with a view of determining variation in design of equipment. R.A.H.

Thermal conductivity of low-temperature insulators. N. H. CHAMBERLAIN. *Refrac. Jour.*, **8** [2], 43–45 (1932).—Imagine a slab of solid material possessing two flat boundary surfaces which are parallel. Let its area be A, its thickness d, and let one flat surface be maintained at a temperature T_1, while the other is maintained at a lower temperature T_2. Under these conditions a flow of heat takes place through the material, the lines of flow being always normal to the hot and cold faces save for a small zone around the edges where the normal flow is upset by an "edge effect." The amount of heat passing from the hot to the cold face is directly proportional to the area of the specimen, providing the edge effect may be neglected to the temperature difference between

its faces, and to the time of flow, and inversely proportional to its thickness. It may therefore be written as follows:

$$\frac{H \propto At(T_1 - T_2)}{d} \quad \text{or} \quad \frac{H = K\ At(T_1 - T_2)}{d}.$$

The constant of proportionality, K, is known as the coefficient of conductivity or specific conductivity of the material in question. Rewriting the equation:

$$K = \frac{Hd}{At(T_1 - T_2)} \quad \text{or} \quad K = \frac{H}{At} \cdot \frac{d}{(T_1 - T_2)}$$

The quantity $\frac{(T_1 - T_2)}{d}$, *i.e.*, the temperature fall across the specimen divided by its thickness, is called the "temperature gradient." Thus the specific conductivity of a substance is the quantity of heat passing through unit area in unit time when the specimen is subjected to a unit temperature gradient. It is usually expressed as calories/sq. cm./sec./unit temperature gradient, the latter being expressed as °C/cm. The values for a few substances showing the order of magnitude of the value to be obtained are as follows: for metals, the value of K lies between the limits 0.01 and 1.00 approximately, for fire brick the values range around 0.003, for glass a value of 0.0017, for ebonite 0.00032, and for air 0.00005 approximately. The conductivity of insulating materials lies, in general, between 0.00009 and 0.0005, *i.e.*, between a value not greatly exceeding that of air and one that is still one hundred to one thousand times less than that of the metals. E.P.R.

Measurement of thermal conductivity. L. JOLY. *Compt. rend.*, **192**, 797–99 (1931).—The arrangement consists of three adjoining chambers, 1, 2, and 3, each 2 m. cube. The wall between 1 and 2 is of cement 75 mm. thick, that between 2 and 3 of the material to be tested. Chamber 2 is maintained at a constant higher temperature, *e.g.*, 60°, and the temperature in 1 and 3 gives approximately the comparative conductivity of the material. To determine the conductivity more accurately, in chamber 2 is placed, with axis horizontal, a cylindrical box, 40 cm. in diameter, with double walls and glass wool between and a thermometer on each side, open at one end. This open end is placed against the wall of the material under examination. Inside the box is an electric heater. The current necessary to maintain the temperature inside and outside the box the same is a measure of the conductivity across the section of material enclosed by the open end of the box. (*B.C.A.*)

The determination of the water permeability of refractory fireclay bodies as a means of distinguishing the structure. OTTO BARTSCH. *Ber. deut. keram. Ges.*, **12** [12], 619–52 (1931).—The measurement of water permeability is of importance in the resistance of refractory materials toward glasses and slags. A water-permeability apparatus was devised. E.J.V.

Comparative tests for determining resistance of fireclay brick to thermal spalling. R. A. HEINDL. *Nat. Glass Budget*, **47** [38], 21 (1932); for abstract see *Ceram. Abs.*, **11** [3], 184 (1932). E.P.R.

High-temperature insulators. J. W. COBB AND T. H. BLAKELY. *Refrac. Jour.*, **8** [2], 46 (1932).—The authors describe a comparatively simple apparatus employed to provide makers and users of heat-insulating brick with information on the thermal conductivity of their products. Such tests were prompted by the demands of fuel economy. The test for thermal conductivity or insulating power can be made on a single brick or two brick. The method used was developed from that of Dougill, Hodsman, and Cobb, in which the lower face of the brick was maintained at the higher temperature and the

amount of heat conducted was measured by the amount of water evaporated from a calorimeter set on the upper cooler face. On account of the smaller quantity of heat transmitted, the calorimeter was displaced by a blackened slab of metal exposed to the air from which the heat loss could be simply calculated. Details are given. E.P.R.

Using alumina for highly refractory purposes. ANON. *Sprechsaal*, **65** [7], 115–16 (1932).—Attempts to produce highly refractory alumina products are described. The best results are secured with a grog mass with which electrically fused alumina is mixed dry with finely powdered clay. The firing should be high to prevent after-shrinkage. Such materials begin to soften at about 1670°, collapse at 1750° with a load of 2 kg., and have a P.C.E. of 38 to 40. M.V.K.

Low-frequency induction furnace and its scope. A. G. ROBIETTE. *Metallurgia*, **4** [23], 155; [24], 175–76 (1931); *Refrac. Jour.*, **8** [1], 40 (1932).—In a submerged ring-type induction furnace for melting copper-zinc alloys containing up to 70% copper and not more than 3% lead, a clay-base refractory has been found satisfactory. For cupro-nickel zinc alloys using the Rohn fritting method in an Ajax-Wyatt furnace, a dry refractory cement containing a binding substance is poured and lightly rammed around a metallic former, the latter being heated by induction to such a temperature that the cement sinters and forms a hard resistant lining. Cupro-nickel and phosphor bronze are now being melted in linings composed of pure quartzites with an admixture of suitable fritting material. The most satisfactory lining for melting pure copper has a corundum base, and the average life obtained is 600 heats. M.V.K.

Refractories for high-frequency furnaces. T. R. MIDDLETON. *Refrac. Jour.*, **8** [2], 47 (1932).—The pre-fired clay or plumbago crucibles have been replaced by linings built up by other methods. Sintered linings, acid or basic, are most generally used. In preparing the lining, 2 to 3 in. of suitably graded refractory is first rammed onto the furnace bottom, and on this is bedded a hollow mild steel cylinder having its bottom end closed. The space between cylinder and coil is then carefully rammed with refractory, the furnace top and spout being finished off with brick and ganister or by any other suitable method. The procedure then consists in charging raw material into the cylinder and melting down slowly; the refractory is thus sintered and bonded to the form of the cylinder. Such linings are satisfactory. Another type of lining is unfired silica or magnesite brick. The brick are of special section, generally built into place without cement. E.P.R.

Carbon monoxide and refractory materials. ANON. *Feuerungstechnik*, **20** [2], 29 (1932).—Besides the destructive influences of high temperature, attack of slag, erosion, sudden changes of temperature, etc., to which refractories are exposed, there is also the destruction by carbon monoxide as seen in the brick of the upper zones of the blast furnace by a gray or violet coloring. It appears wherever gases containing carbon monoxide at 400 to 500° come in contact with refractories, due to the reversibility of the reaction, $C + CO_2 = 2CO$, causing a precipitation of carbon at lower temperatures. This reaction with the precipitation of carbon takes place normally very slowly, but is accelerated by different catalyzers such as iron, nickel, cobalt, platinum, silica, alumina, etc. The action of the last two materials is slow. The most active catalyzer is metallic iron from which carbides rich in carbon are formed. These carbides disintegrate with the separation of carbon and again form carbides, so that small quantities of iron can split unlimited quantities of carbon monoxide with the separation of carbon in the form of soot. The iron present in refractory materials is equally able to catalyze the disintegration of CO at 430 to 470° when present as a metal. The precipitated soot shatters the refractory completely although slowly. The appearance of the phenomenon is varied, depending on the degree of distribution of the iron. Several cases of the destruction of refractories by carbon monoxide are described. Means of preventing it are (1) use of

grog poor in iron, (2) use of materials fired to high temperatures, (3) use of brick rich in silica, and (4) use of dense brick. M.V.K.

Refractories for work at high temperatures. E. RISHKEVICH. *Chem. Met. Eng.*, **39** [2], 85 (1932).—The following commercial high refractories are discussed: (1) zirconium silicate, (2) pure alumina, (3) spinel, (4) beryllium oxide, (5) zirconium oxide, (6) magnesium oxide, and (7) thorium oxide. The physical properties of these materials are given, as well as the methods of molding, firing, and limits of use of the refractory products. See also *Ceram. Abs.*, **10** [6], 432 (1931). G.R.S.

Refractory materials for electric furnaces. IV. ALFRED B. SEARLE. *Metal Ind.* [London], **39** [21], 483 (1931).—For the preliminary refining of gold and silver, furnaces lined with fireclay brick are usually found to be most satisfactory, though silica brick and magnesite brick are largely used for the roofs of such furnaces and sometimes for the side walls. The use of zirconia and other highly refractory materials is undesirable because of the great difficulty experienced in recovering any absorbed metal. For the same reason, a mixture of dead-burned magnesite and chromite is not popular although its durability is exceptionally high. Furnaces lined with silicon carbide, alundum, and zirconia have been tried, but appear to afford no more satisfaction than a carefully-prepared mixture of grog and clay. S. discusses the refractories found most serviceable for furnaces of different materials. For Part III see *Ceram. Abs.*, **10** [10], 707 (1931). M.V.K.

Refractory coating for lime and cement kilns. E. DE LA FOLLYE DE JOUX. *Rev. mat. constr. trav. pub.*, No. 268, pp. 9–11*B* (1932).—(1) Brick used in the zone of reheating should be acid. (2) Brick used in the firing zone should be alkaline. (3) Brick used in the cooling zone may be less refractory but must resist mechanical wear at high temperature and sudden changes to temperature. See also *Ceram. Abs.*, **10** [10], 707 (1931). M.V.K.

Brick for lining cement kilns. ANON. *Brit. Clayworker*, **40** [476], 323 (1931).—Manufacturers of Portland cement require brick having several conflicting properties for lining kilns in which cement is clinkered. (1) The refractoriness of the lining should at least be equal to cone 34 (1750°C) because the temperature of the clinker reaches 1500 to 1550°C and that of the flame in contact with the lining, still higher. (2) Highly siliceous brick are useless because the clinker attacks them violently and corrodes them rapidly. Basic brick appear impracticable at present and the best material available is a highly aluminous one. (3) A dense structure is desired, *i.e.*, having a volume weight of not less than 2.4. (4) The brick must have low shrinkage in use to enable them to retain their position in the kiln and not allow undue penetration of clinker between them. (5) High resistance to abrasion is required because the clinker traveling through the kiln has both an abrading and a plucking action. A good lining should last 10 to 12 months in the hottest parts of the kiln. R.A.H.

Silica brick for coke ovens. P. B. ROBINSON. *Brit. Clayworker*, **40** [478], 409–12 (1932); for abstract see *Ceram. Abs.*, **11** [3], 182 (1932). R.A.H.

Electric furnaces for melting copper and copper alloys. W. L. GOVIER. *Metal Ind.* [London], **39** [23], 535–37; [24], 564–66 (1931).—L. describes different types of electric furnaces. Trials of new refractories and of modifications in design are being continually studied. In the loop furnace good electromagnetic coupling demands small distances between metal and primary coils, and it is only with better refractories that this will be done. Improvements will probably be made by altering physical conditions of these substances rather than by employment of refractories of new chemical composition. The use of linings constructed of prefired brick shaped to form the secondary loop have given satisfaction. M.V.K.

Refractory materials. HAYES. *World Power*, **1**, 49–54 (1932); *Refrac. Jour.*, **8**

[2], 76 (1932).—H. discusses the question of resistance to corrosion, such factors as the nature and physical properties of the matrix of the material, its capacity to resist internal strains, the cohesion between the matrix and grog particles, and the effect of temperature variation on the matrix. Friability or the tendency of a refractory composition to crumble under service conditions is often due to the absorption of metallic oxides. Other properties of refractory materials dealt with are thermal and electrical conductivity, reversal and permanent expansions, sudden changes in temperature, and the causes and tests for spalling. E.P.R.

Silicon carbide and electro-corundum. R. SCHNEIDER. *Tonind.-Ztg.*, **56** [8], 105–107 (1932).—Silicon carbide is formed in the following way:

$$\begin{aligned} SiO_2 + 2C &= Si + 2CO \\ Si + C &= SiC \\ \hline SiO_2 + 3C &= SiC + 2CO \end{aligned}$$

Besides these reactions, oxidized silicon carbides are formed of the type C_nSi_nO. The reactions take place in an electric furnace of the dimensions 45 x 9 x 6 ft. In the axis of the furnace is placed a horizontal core of coke. Around it are arranged the raw materials, coke, and quartz sand. The core is heated by passing an electric current of 2000 volts through it. Electro-corundum is made from bauxite by means of the electric arc. Illustrated. W.M.C.

Graphite crucibles. E. R. THEWS. *Tonind.-Ztg.*, **56** [5], 60-62 (1932).—Advantages of the use of graphite for crucibles comprise high refractoriness, good thermal conductivity, small losses by oxidation, and high chemical resistivity. Requirements are outlined for the clays to be used for graphite crucibles. Analyses are given of some crucibles. Illustrated. W.M.C.

Properties of fire brick. A. J. DALE. *Trans. Ceram. Soc.* [Eng.], **29**, pp. 326–28 (1930); *Refrac. Jour.*, **6** [65], 184 (1931).—As the result of an extended research, together with a study of the physical properties such as porosity, density, refractoriness under load, etc., it is concluded that the value of a clay-bonded refractory is determined more by the type of grog used than by the clay bond. E.P.R.

Chrome-silica refractory brick. ANON. *Chem. Trade Jour.*, **90** [2330], 58–59 (1932).—Experiments on chrome-silica brick have been completed. It is shown that certain chrome-silica brick are mechanically stronger at high temperatures than the normal chrome brick. Also these products have a smaller reversible expansion than silica brick, and the possibility of permanent expansion is reduced by the greater degree of conversion of the quartz, mainly to tridymite. Other properties of these brick suggest definite fields of application in the steel industry. M.V.K.

Black Dinas (brown silica brick) in Martin kilns. ANON. *Feuerfest*, **8** [1], 9–10 (1932).—In a series of articles, the *Technika* (Russian) describes the results of using brown silica brick (converted through the addition of mineralizers) in Martin kilns. Groum-Grjimailo added slag containing iron to the silica mass to promote tridymitization of quartz. To rock quartzites were added 2.5% Martin slag, 2% lime, and powdered charcoal. A Martin kiln walled with such brick withstood 450 melts. Several metallurgical plants are using such brick with good results. M.V.K.

Red-stained silica brick. HANS GOLLA. *Tonind.-Ztg.*, **55** [93], 1285–87 (1931).—G. concludes that red iron spots are promoted by the use of quartzites rich in iron and poor in alumina. Lime aids the formation of spots which disappear at higher temperatures. The spots are due to a precipitation of iron oxide. M.V.K.

Red-stained silica brick. E. LUX AND O. KRAUSE. *Tonind.-Ztg.*, **55** [101], 1405 (1931).—The conclusions by Golla (see preceding abstract) on red-stained silica brick

are confirmed by means of X-ray analysis. In the red spots are crystals of iron-calcium compounds. W.M.C.

Zirconia brick. W. HERRMANN. *Refrac. Jour.*, **8** [2], 76 (1932); for abstract see *Ceram. Abs.*, **11** [2], 114 (1932). E.P.R.

New two-stage firing and preparation of slate clay from Neurode. R. RADEMACHER AND E. GOEBEL. *Feuerfest*, **8** [1], 1–6 (1932).—The authors describe a new two-stage method of firing and manufacturing grog clay brick. This method yields great economies in the production of a highly basic material and is an advancement in the manufacture of grog brick of high value. The advantages of grog brick over ordinary brick are as follows: (1) low flux content, especially of iron oxide, and freedom from slag-like impurities containing iron, which increases refractoriness, (2) softening under pressure beginning over 1500°, (3) low and uniform shrinkage, (4) high stability to sudden temperature change, and (5) hardness and high resistance to abrasion. M.V.K.

Improving low-grade bauxites. ANON. *Rev. mat. constr. trav. pub.*, No. 255 (1930); *Ind. Silicati*, **10** [1], 14 (1932).—Bauxites with a low alumina and high iron and silica content were ground and fired to transform the sesquioxide Fe_2O_3 into the magnetic Fe_3O_4. M.V.K.

Magnesite. ANON. *Brit. Clayworker*, **40** [478], 391–92 (1932).—The varying conduct of the refractory is due to differences both in the chemical composition and physical structure of the raw materials. Trouble with the finished brick is also due to the method of grinding, tempering, and bonding and the system of conducting the drying and final firing. A brief discussion on crucibles prepared from magnesite, and the increased use of magnesite for basic-lined converters in the refining of copper and nickel and in the metallurgy of silver is included. R.A.H.

Ukrainian kaolin. ANON. *Rev. mat. constr. trav. pub.*, No. 268, p. 16*B* (1932).—After long researches it was found possible to use kaolin as raw material for the production of aluminum. The kaolin deposits in the Ukraine are enormous. Alumina is extracted by an alkaline method. Kaolin heated to a certain temperature is mixed in a definite proportion with soda and chalk. This mixture is pulverized and molded into brick which are calcined at 900°. Aluminum produced in this way is of excellent quality. M.V.K.

Transformation of kaolinite into mullite. P. P. BUDNIKOFF AND W. G. POPOFF. *Refrac. Jour.*, **8** [2], 76 (1932); for abstract see *Ceram. Abs.*, **11** [2], 111 (1932). E.P.R.

Refractory materials. ALEXANDER H. HAYS. *Blast Fur. Steel Plant*, **20** [3], 292–94 (1932).—Fireclay and silica products, magnesite, bauxite, mullite, diaspore, corundum, chromite, silicon carbide, and zirconia are listed as the chief refractory materials with the first two ranking as the most important and most largely used, and the others of more or less specialized nature. The characteristics of the various conditions encountered in furnace walls are listed. The nature, properties, and occurrence of fire clays is discussed, as are the different types of silica used in refractory manufacture. A detailed explanation of the volume changes silica undergoes at various temperatures and their effect on the refractory is given. E.J.V.

Ukrainian Institute of Silicates. ANON. *Feuerfest*, **7** [11], 175 (1931).—The Russian Silicate Institute in Charkov and Kiev, which is two years old, published a series of papers devoted to refractories among which are the following: (1) I. I. Moratchevski, "Plasticity of Ukrainian kaolins" (for abstract see *Ceram. Abs.*, **10** [11], 809 (1931)); (2) P. P. Budnikoff and I. S. Smeljansky, "Tridymitization of quartz in silica brick in the presence of mineralizers" (for abstract see *ibid.*, **10** [12], 847 (1931)); (3) B. S. Lyssin and J. A. Galabutskaya, "Researches on Ukrainian kaolins" (for abstract see *ibid.*, **9** [7], 575 (1930)); (4) J. I. Sherman, "Molding of ceramic objects" (for

abstract see *ibid.*, **10** [11], 788 (1931)); (5) A. K. Babko, "Volumetric determination of silicon dioxide in silicates" (for abstract see *ibid.*, **11** [2], 139 (1932)); (6) S. I. Nazarevich and M. J. Andreev, "Ukrainian flint as lining for ball mills"; (7) P. P. Budnikoff, G. Kukolev, and I. Smeljansky, "Influence of the alumina content in glass on the degree of corrosion of grog blocks in glassmelting kilns" (for abstract see *ibid.*, **11** [2], 87 (1932)); (8) I. Smeljansky and A. S. Frenkel, "Manufacture of silica brick of high quality from crystalline quartzites of Krivoi-Rog for steelworks"; (9) A. S. Berkman, "Rational use of firing space in kilns." M.V.K.

Fifty years manufacture of refractory products. W. Steger. *Tonind.-Ztg.*, **56** [13], 184–86; [14], 200–201; [15], 213–14 (1932).—Ancient plants and the installations used fifty years ago for drying the clay, crushing and mixing machines, means of forming and drying the products, and periodic and continuous operated kilns are described. Illustrated. W.M.C.

Bosnian magnesite deposits. J. Schadler. *Berg-Hutten.*, **79** [4], 146–52 (1931); *Feuerfest*, **8** [1], 12 (1932).—A description is given of some magnesite deposits in Bosnia. M.V.K.

BULLETINS

Bauxite and aluminum in 1930. C. E. Julihn. Bur. Mines, *Mineral Resources U. S.* 28 pp. 5¢. R.A.H.

Chromite in 1930. L. A. Smith. Bur. Mines, *Mineral Resources U. S.* 24 pp. 5¢. R.A.H.

Book Review

Silicate Industry of U. S. A. with a Description of Refractory and the Other Ceramic Materials. P. P. Budnikoff. State Scientific Technical Publication, Charkow, U.S.S.R., 1932. 86 pp., 97 illustrations. This publication is the result of the author's personal impressions and study during his recent trip to America. B. describes (1) the method of dry pressing and the production of high aluminum, magnesite, and chrome brick, (2) production and use of Dinas brick, (3) production and use of silicon carbide, (4) the uses of vacuum filters, presses, and handling equipment, and (5) production of gypsum and Portland cement. The use of gypsum materials is well illustrated. The progress attained by Germany in the production of alumino-silicate cements is described. The technique and production and the high quality of American building materials is praised. Alexis A. Zakharoff

PATENTS

Refractory article. David B. Sears. U. S. 1,843,175, Feb. 2, 1932.

Furnace wall. James V. Done. U. S. 1,843,384, Feb. 2, 1932. Frank B. Bigelow. U. S. 1,845,902, Feb. 16, 1932. George W. Davey. U. S. 1,848,110, March 8, 1932.

Chrome refractory and its method of manufacture. Russell P. Heuer. U. S. 1,845,968, Feb. 16, 1932.

Molding articles from a slip or plastic mass. Charles William Speirs. U. S. 1,846,279, Feb. 23, 1932.

Manufacture of articles of zirconium oxide. Eugen Rishkevich. U. S. 1,847,101, March 1, 1932.

Checkerwork. Alvin A. Claassen. U. S. 1,848,242, March 8, 1932.

Furnace arch. Percy W. Matthews. U. S. 1,848,737, March 8, 1932.

Refractory structures of furnaces. L. S. Longennecker. Brit. 364,955, Jan. 20, 1932.

Producing refractory bodies. BRITISH THOMSON-HOUSTON CO. Brit. 364,993, Jan. 20, 1932.

Refractory materials. HARTFORD-EMPIRE CO. Brit. 364,850, Jan. 20, 1932. W. H. DANIELS. Brit. 365,779, Feb. 3, 1932.

Terra Cotta

Crazing as consequence of tensions from humidity. H. MÖHL AND A. MÖHL. *Sprechsaal*, **65** [3], 40–42 (1932).—The researches of H. G. Schurecht, H. H. Holscher, and R. G. Mills on delayed crazing are as follows: (1) character and measurements of humidity tensions, (2) autoclave tests, stability of the coat, and chilling test, (3) porosity, humidity tensions, and prevention of crazing, and (4) influences on humidity tensions. M.V.K.

Blue smoking of roofing tile. A. NAWRATH. *Tonind.-Ztg.*, **56** [8], 107–108 (1932).—Periodic kilns are fired to the finish, then all openings are closed, and oil, wood, asphalt, or other substances which develop large amounts of hydrocarbons are introduced. The kilns are slowly cooled until the tile cease to glow. The best results are from clays which fire to a red color. W.M.C.

Manufacture of Dutch tile with grog addition. ANON. *Tonind.-Ztg.*, **56** [6], 79 (1932). W.M.C.

Special stoneware products. ANON. *Tonind.-Ztg.*, **56** [9], 122–23 (1932).—Difficulties in the manufacture of these products are discussed. W.M.C.

Calculation of the prices of terra cotta. F. THEILMANN. *Tonind.-Ztg.*, **56** [8], 109–10 (1932).—Some illustrations are given for calculation of piecework. W.M.C.

PATENTS

Preparing clay products. CHARLES W. PARKS. U. S. 1,848,743, March 8, 1932. The method of coloring a clay product which comprises heating it in a chamber containing air, closing off the chamber, discontinuing the heat, and then introducing a combustible mixture into the chamber after the contents of the chamber have cooled below their maximum temperature but before the product has been completely cooled.

Ashlar block protector. RICHARD F. DALTON. U. S. 1,846,676, Feb. 23, 1932.

Roofing tile. L. F. LUDOWICI AND C. LUDOWICI KOMMANDIT-GES. AUF AKT. Brit. 366,526, Feb. 17, 1932.

White Wares

Buckling of wall tile. HEWITT WILSON. *Jour. Amer. Ceram. Soc.*, **15** [4], 252–60 (1932).

Function and action of opacifiers. LEANDER R. KIRK. *Jour. Amer. Ceram. Soc.*, **15** [4], 226–30 (1932).

Effect of alkaline cleansing materials on color-decorated hotel dinnerware. K. ENDELL. *Ber. deut. keram. Ges.*, **12** [11], 548–55 (1931).—The various types of porcelains and cleansing materials are considered. Methods of testing used and results obtained in the laboratory are discussed. A summary of results obtained in answer to a questionnaire sent out in regard to rinsing machines and practical tests run in hotel dishwashing machines is presented. The recommendations arrived at are that the cleansing solutions should have a temperature of 50 to 60°C while rinsing with clear water should be done at about 90°C, both operations being of about one minute duration. Six color-decorated porcelains were tested for the effect of five 1/4% cleansing material solutions at 40 to 50° which are used in regular practice without any harmful effects. Several other experimental tests were made. The ultimate conclusion was that color-decorated

porcelains are in no way attacked by soda, neutral soaps, Persil, and Imi in the washing chamber of a modern dish-washing machine at temperatures of 40 to 60°. Persil is a compound consisting of 72% granular soap, 15.5% calcined soda, 10.0% perborate and 2.5% sodium silicate while Imi consists of 67% trisodium phosphate, 25% soda, 5.0% sodium silicate, and 3.0% water. The intensity and gloss of the color remain unchanged in these treatments. See also article by H. Kohl, *Ceram. Abs.*, **11** [3], 187 (1932). E.J.V.

Resistance of colored enamels to dilute acids and a process for the determination of their lead solubility. W. FUNK AND M. MIELDS. *Ber. deut. keram. Ges.*, **12** [11], 535–48 (1931).—Factors which influence the possibility of attack by a dilute acid on an enamel on porcelain are (1) the composition of the enamel, (2) kind of acid, (3) temperature and duration of the action of the acid, (4) method of application of the enamel on the porcelain surface (powder, spreading on with a brush, applying by hand, printing, etc.), (5) the thickness of the enamel layer applied, and (6) the temperature at which the enamel was fired. The action of acetic and hydrochloric acid on the fired enamels is not similar and the acids do not have a definite relation to one another for the individual colors. It was proposed to designate an enamel as practically acid resistant (1) if it shows a good gloss in medium heavy coats, (2) if it does not lose its specific color tone when not in excessively heavy coats, and (3) if on treating 100 sq. cm. of the fired enamel surface with acetic or hydrochloric acid of the specified concentration, no more than 0.0005 g. of lead goes into solution and the enamel is not changed in gloss and color thereby. E.J.V.

Manufacture of glazed pans. ANON. *Brit. Clayworker*, **40** [478], 406–408 (1932).—Pan making is described beginning with the preparation of the clay, "throwing," drying, glazing, wetting, and firing. R.A.H.

Electrical conductivity of porcelain at high temperatures. R. JÄGER. *Refrac. Jour.*, **8** [1], 40 (1932); for abstract see *Ceram. Abs.*, **9** [6], 443 (1930). E.P.R.

CORRECTION

On page 188 of the March, 1932, *Ceramic Abstracts*, the first reference in the abstract entitled "A nonsiliceous porcelain with a pure fluorite base," by A. DAMIENS, should read *Compt. rend.*, **192** [20], 1235–37 (1931).

BOOK

Kelsterbach Porcelain. (Das Kelsterbacher Porzellan.) KURT RODER. Published by Gesellschaft Hessischer Bucherfreunde, Darmstadt. Price 65 M. Reviewed by W. B. Honey in *Connoisseur*, **89** [366], 119 (1932).—The variety of German porcelain is due to the fact that in the 18th Century the ruler of each state desired his own porcelain factory for reasons of glory and finance, resulting in seven major and many minor factories of which Kelsterbach is one. A comprehensive study of this ware with a perspective view of the whole German porcelain history is given. E.B.H.

PATENTS

Water closet. JOHN C. DUNER. U. S. 1,845,252, Feb. 16, 1932.

Ceramic material. WALTER JEFFERSON SCOTT. U. S. 1,847,102, March 1, 1932. Mixing ceramic substances with a solution of paraffin and evaporating the solvent in which the paraffin is dissolved.

Ceramic material and manufacture of ceramic articles. WALTER J. SCOTT. U. S. 1,847,196, March 1, 1932. Forming ceramic material into granules, coating the granules with a small amount of soap, and molding the resulting material under pressure.

Making ceramic material. LEON I. SHAW AND WALTER J. SCOTT. U. S. 1,847,197,

March 1, 1932. Mixing ceramic substances with a solution of paraffin and a material having a melting point higher than that of paraffin.

Sagger. DAVID V. ROBISON U. S. 1,848,200, March 8, 1932.

Teapots, etc. B. S. YOUNG. Brit. 366,207, Feb. 10, 1932.

Manufacture of shaped ceramic products of pure white shades. I. G. FARBENINDUSTRIE AKT.-GES. Brit. 366,890, Feb. 17, 1932.

Equipment and Apparatus

Grinding-plant development. ANON. *Chem. Trade Jour.*, **90** [2331], 90 (1932).—A description of a new mill, "Miracle," is given. The mill works on the basic principles of pulverization by shattering and ejection instead of by grinding and retention. When the mill is in operation, the material is shattered in mid-air and not ground between two surfaces of pressure. M.V.K.

Drying and crushing installations of high efficiency for gypsum plants. PIKALLO. *Tonind.-Ztg.*, **56** [16], 224–27 (1932).—Improvements made in drying and crushing installations by using the short tube mill are described. Illustrated. W.M.C.

Steel for crushing machines. ANON. *Tonind.-Ztg.*, **56** [5], 64 (1932).—Different materials used for crushing machines are reviewed. The steel should be hard and tough. W.M.C.

Equipment for the cleaning of metal. XIV. R. W. MITCHELL. *Metal Cleaning & Finishing*, **4** [2], 71–78 (1932).—M. presents data on the use of overhead conveying systems, mechanical agitators, baskets, trays, racks, etc., in connection with cleaning operations. Illustrated. For Part XIII see *Ceram. Abs.*, **11** [4], 229 (1932). E.J.V.

Foundations for clayworking machinery. ANON. *Brit. Clayworker*, **40** [478], 390 (1932). R.A.H.

Shearing strength of clays. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. *Pottery Gaz.*, **57** [657], 352–53 (1932).—A machine designed for measuring the shearing strength of plastic bodies and known as the Pachimeter is described. Construction details, use, and advantages of the method are enumerated. E.J.V.

Innovations in brick machinery. GROSS. *Tonind.-Ztg.*, **56** [15], 214–16 (1932).—Several new machines have been developed for the manufacture of common brick and hollow tile. Illustrated. W.M.C.

Science and practice of drying. X and XI. ANON. *Brit. Clayworker*, **40** [476], 346–48; [478], 384–87 (1932).—The layout of a small brickworks with a chamber drier is described. The modern Keller humidity drier is discussed in some detail as well as the double circuit humidity chamber drier. For Parts VIII and IX see *Ceram. Abs.*, **11** [3], 191 (1932). R.A.H.

Artificial brick drying. F. SCHMIDT. *Tonind.-Ztg.*, **56** [6], 78 (1932).—This is a discussion of the paper by Thor (for abstract see *Ceram. Abs.*, **11** [3], 191 (1932)). W.M.C.

Improvements in brick drying. K. O. SCHULZ. *Tonind.-Ztg.*, **56** [13], 186–87 (1932). W.M.C.

Building costs of artificial drying plants. G. HARTMANN. *Tonind.-Ztg.*, **56** [9], 121–22 (1932).—This is a discussion of the paper by Huettemann (for abstract see *Ceram. Abs.*, **11** [4], 255 (1932)). W.M.C.

Tensometer and its accessories. ANON. *Metal Ind.* [London], **39** [11], 247–49 (1931).—The tensile strength machine known as the Hounsfield tensometer is described in detail. The test pieces which can be used in the tensometer are of very small dimensions (only $^1/_{50}$ sq. inch in area). It can be used also for brittle materials. M.V.K.

Practical use of p_H sets in laboratory control. PERKINS BOYNTON. West Va. Univ. Eng. Expt. Sta., *Bull.* No. 4, **16** [3], 39–41 (1931). E.C.C.

New developments in water-purification equipment. MARTIN E. FLENTJE. West Va. Univ. Eng. Expt. Sta., *Bull.* No. 4, **16** [6], 78–84 (1931). E.C.C.

Rapid method of examining soils. I. Measurements of rolling weights. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. *Jour. Agric. Sci.*, **22** [1], 135–44 (1932).—The authors designed a machine to determine the "heaviness" of a soil by rolling a small shaped cylinder of wet soil between two plates under constantly increasing pressure. The length of the cylinder is observed during the rolling until it begins to "roll out" (lengthen and thin) at which time the load is read. This value is taken as an index of the "heaviness" of the soil. One wood and one ground-glass plate are used rather than two smooth glass plates, since the latter cause the soil cylinder to slip rather than to roll, resulting in its flattening before lengthening. The test requires about seven minutes to run and is not suitable for sandy soils. Illustrated. J.L.G.

Research on cyclone dust collectors. LOUIS C. WHITON, JR. *Rock Prod.*, **35** [4], 78–81 (1932); *Power Plant Eng.*, **36** [5], 212–13 (1932).—W. describes research to determine the efficiency of cyclone dust collectors 1, 2, and 3 ft. in diameter and of different heights and shapes, with reference to collection velocity, temperature, mesh of dust particles, grain loading (density of gas and dust mixture), arrangement of outlet pipe, and rate of emptying cyclone. Conclusions are drawn regarding dusts of finer sizes and the efficiency and capacity of mechanical dust collectors. W.W.M.

Pipe-line transportation of powdered material. FREDRICH SCHULTE. *Power Plant Eng.*, **36** [6], 252 (1932).—Pneumatic conveying can be done either by suction which is preferable for distances up to 450 yd. or by compressed air for distances up to 2000 yd. For greater distances intermediate stations must be installed. In many cases suction and pressure are combined. E.P.R.

PATENTS

Transforming molten matter such as slag into frothy porous matter. THEODOR GILLER. U. S. 1,843,716, Feb. 2, 1932.

Shale reamer. JAMES J. SANTIAGO. U. S. 1,844,370, Feb. 9, 1932.

Electrodepositing chromium. COLIN G. FINK AND HUGH DAVID MCLEESE. U. S. 1,844,751, Feb. 9, 1932.

Attachment for brickmaking machines. RUFUS ISENHOUR. U. S. 1,847,966, March 1, 1932.

Testing the strength of materials. ALBERT H. EMERY, JR. U. S. 1,848,468, March 8, 1932.

Relay devices for controlling, regulating, recording, etc. R. W. JAMES. Brit. 364,660, Jan. 20, 1932.

Kilns, Furnaces, Fuels, and Combustion

Continuous electric decorating kiln. EDWIN M. KNOWLES CHINA CO. *Ceram. Ind.*, **18** [3], 174–76 (1932).—An electric recuperative kiln construction is described, operating results are discussed, and many advantages of the kiln are cited among which are low operating and maintenance cost, small floor space requirement, superior firing conditions, short time cycle, and convenience. W.W.M.

Conditions for the correct functioning of a circular kiln. ANON. *Corriere Ceram.*, **13** [1], 21 (1932). M.V.K.

Rapid firing in the ring kiln. ANON. *Tonind.-Ztg.*, **56** [14], 196–97 (1932).—The possibilities of increasing the rate of firing in ring kilns are discussed. W.M.C.

Production of alloy steels in coreless induction furnaces. O. DÖRRENBERG AND N. BROGLIO. *Stahl Eisen*, **50**, 617–26 (1930).—After a review of the development of the high-frequency induction furnace and a discussion of the electric principles on which it is constructed, an account is given of the installation and performance of one of these furnaces in a German steelworks. The transformer efficiency is about 78 to 80%, and the current consumption for a 300-kg. charge starting in the cold is 600 kw.-hr./ton to effect complete fusion and 730 to 790 kw.-hr./ton until casting is complete; the average duration of melting is 90 to 100 min. Curves showing the electric conditions during the melting of several charges are given, and the operation of the furnace is compared with that of a gas-fired crucible furnace. (*C.A.*)

Progress in the construction and operation of the coreless induction furnace used for steel making. NINO BROGLIO. *Stahl Eisen*, **51**, 605–13, 635–44 (1931).—Further experiments on the previously described electric induction furnace (see preceding abstract) are discussed. By various changes in the process the durability of the crucibles was greatly increased. Tables give the heat balance during a melt, the power consumption and time required, and the performance of this furnace as compared with those of the gas crucible furnace, open-hearth, and electric arc furnaces. The result of this comparison makes it possible to calculate the limits within which the coreless induction furnace is economical. The possibility of raising the temperature of the melt to a point required by some special steels is discussed. The advantages of the melt kept in violent motion are contrasted with the disadvantages caused by slag inclusions in the finished steel. Under careful control, however, faultless steel can be obtained, and the slag, too, can be kept within predetermined composition. Finally it is shown that the changes in temperature during the melting operation can be determined accurately by thermoelectric and optical methods; on the other hand, the calculation of the temperature from the amount of electric energy consumed is not reliable because of the various fluctuating electric and magnetic phenomena occurring during melting. A detailed discussion of the subject by several authorities is appended. (*C.A.*)

Heating up of a modern battery of silica ovens. E. W. TURNER. *Gas World* [Coking Section], **95** [2457], 20–21 (1931); *Feuerfest*, **8** [1], 9 (1932).—Factors to be considered when heating up modern silica ovens are different from those observed in older constructions of grog or half-silica brick. These factors are discussed in detail. The fire should be increased gradually and after 3 weeks of heating, the temperature, which must be controlled all the time, may reach 100°C in the upper ends of the vertical channel. In the second stage, coal firing is used and the air valves are opened wider. The temperature is increased to 600°C for the next 4 weeks. The critical temperatures at which the heating should be especially careful lie at 120°, the conversion point of α-tridymite into β-tridymite with an expansion of 0.2%; at 230°, at which α-cristobalite with a coefficient of expansion of 1.2% is converted into β-cristobalite; and at 570°, the temperature of conversion of quartz with an expansion of 0.4%. These critical temperatures must be passed in the course of several days, because not all the parts of the oven have the same temperature; the generators are always colder. Mixtures of coal and coke can be used for heating after 400°. For the last period, for reaching the temperature of operation of about 1000°, coke of 50 mm. grain size is the suitable fuel. M.V.K.

Heat content of fuel. ANON. *Power Plant Eng.*, **36** [5], 200 (1932).—Natural gas has a heat content considerably above that of manufactured gas and on a pound basis considerably more than other common fuels. Tabulated heat values of these various fuels on both the conventional unit and pound basis are as follows:

	B.t.u./ conventional unit	B.t.u./ pound
Natural gas	1,100,000 per M cu. ft.	22,000
Manufactured gas	530,000 " "	11,500
Bottled gas	100,000 " gal.	21,500
Kerosene	126,000 " "	19,100
Gasoline	122,000 " "	20,100
Fuel oil	135,000 " "	18,000
Anthracite coal	27,000,000 " ton	13,500
Bituminous coal	28,000,000 " "	14,000
Coke	27,000,000 " "	13,500
Electricity	3,412 " kw.	

E.P.R.

Properties of coal which affect its use in the ceramic industry. WILLIAM E. RICE. *Mining & Met.*, **13** [303], 11 (1932).—R. describes briefly the purposes and methods of burning of coal in ceramic kilns, and the qualities of the coal that best fulfill the requirements imposed by these purposes and methods. The ideal coal is one that produces a long smokeless flame, does not cake strongly in the fuel bed, is low in moisture, ash, and sulphur, high in calorific value, and has an ash of high softening temperature. The coal should be clean and of uniform size, preferably about 2- by 4-in. egg, so that it will burn uniformly in the small furnaces or kilns. It should be hard enough to withstand shipping and handling without breaking. The ash should be low in content of sulphur and iron because these substances in the ash that is deposited on the ware in the kiln may cause discoloration. The deviations from the ideal qualities of some coals that are used are discussed with reference to the conditions under which satisfactory results are secured. E.J.V.

Coal preparation for petrographic examination. K. LEHMAN AND E. HOFFMAN. *Brennstoff-Chem.*, **13** [2], 21–29 (1932).—The formation of coal and methods of petrographic examination are explained. The petrographic constituents, the methods of treatment of the coal to separate them, and the manner of making petrographic analyses are presented in detail. As a result of the experimental work, it is believed that certain coals may be more economically used than at present. Illustrated with photomicrographs and diagrams. J.L.G.

Determination of nitrogen in coal according to the method of Kjeldahl. E. BÖRNSTEIN AND A. J. PETRICK. *Brennstoff-Chem.*, **13** [3], 41–45 (1932).—The Kjeldahl method requires the decomposition of the coal with sulphuric acid in contact with potassium sulphate, mercury, or copper sulphate. The diluted mixture is treated with sodium hydroxide which contains sodium sulphide. The ammonia is distilled off and determined by titration. The authors experimented with the effect of catalysts on the determination in the case of three coals. The values obtained were lower in all cases than those obtained by the method of Lambris. The best results were obtained in the presence of platinized asbestos, manganese, and zinc dust. The ash constituents of the coal (iron, calcium, and magnesium compounds) appeared to have no influence on the determination. The higher the temperature at which the reaction occurred, the greater were the nitrogen losses. J.L.G.

Pulverized fuel and its application. R. JACKSON. *Metal Ind.* [London], **39** [26], 605–608 (1931).—The chief advantages of using pulverized fuel are as follows: (1) complete combustion, (2) perfect control, *i.e.*, the coal and air are each controllable, an oxidizing or de-oxidizing flame can be obtained at will, and the rate of burning can be adjusted to suit the requirements at any moment, (3) flexibility, *i.e.*, combustion is very rapid and the furnaces can be quickly brought up to heat from cold and shut down as soon as the work is completed, (4) mellow heat, and (5) reduction in labor.

M.V.K.

Advantages of gas for firing rotary kilns. E. DE LA FOLLYE DE JOUX. *Rev. mat. constr. trav. pub.*, No. 265, pp. 401–402 (1931); *Pit & Quarry*, **23** [10], 77 (1932).—The most important advantages are (1) utilization of residuary gas from other industries, or use of fuel of low quality which could not be used without gasification, (2) minimum cost of maintenance and power, the latter not being comparable with that which the crushing of fuel necessitates, and (3) production of highly pure objects required in many industries. M.V.K.

Improving the quality of gas. ARTHUR ROSENFELD. *Sprechsaal*, **65** [6], 97–98 (1932).—R. describes the development of gas firing in glassworks, and discusses the possibility of increasing the efficacy of generator gas for kilns fired with low-grade fuel, *e.g.*, wood, peat, or brown coal of low quality. The processes occurring in the generator are explained. M.V.K.

Volume and temperature of gas mixtures. E. ANDERSON. *Chem. Met. Eng.*, **39** [2], 80 (1932).—A suggestion is given to simplify calculations of the volume of mixtures of two or more gases at different temperatures, *e.g.*, stack gases with mixtures of hot furnace gases and cold air. G.R.S.

Graphical determination of the velocity of a gas from a Pitot tube reading. A. ALISON. *Glass*, **8** [5], 184–85 (1931).—An explanation with diagrams is given of a Pitot tube used to measure the volume of gas or air flowing in a main or duct. From readings on the tube the velocity can be found by means of a nomograph. G.R.S.

Koller gas producer. ANON. *Amer. Glass Rev.*, **51** [21], 17 (1932).—The Koller type gas producer is adaptable to the gasification of any type fuel. E.P.R.

Principles of gas-flow measurement. R. F. BROWN. *Mech. World*, **91** [2352], 95 (1932).—Calculating the flow of gas along a pipe is usually a matter of estimating its velocity, either by obtaining a dynamic head or by locally increasing the velocity and measuring the consequent fall in static head. There are four methods in present-day use, (1) the Pitot tube, which works in the former manner, and (2) the orifice plate, (3) the nozzle meter, and (4) the Venturi meter, which operate on the latter principle. E.P.R.

Recent developments in gas burners. W. TRINKS. *Blast Fur. Steel Plant*, **20** [3], 274–79 (1932).—The inspirator, injector, or induction type of burner is now marketed by a number of manufacturers. In the "high pressure" type of inspirator burner, the gas under pressure induces the air (usually from the atmosphere), while in the "low pressure" type, the air induces the gas which is applied at atmospheric pressure or a very slight excess pressure from a regulator. In a theoretical consideration of this type burner T. takes up also two-stage induction and multi-jet induction, and discusses the constancy of air-to-gas ratio. Illustrated. E.J.V.

Economy of electric firing in the ceramic industry. FRANZ HAUTMANN. *Sprechsaal*, **65** [6], 95–97 (1932).—H. compares the performance of an electric two-track tunnel kiln with that of a circular kiln heated by coal and points out the advantages in using the former including (1) the possibility of firing ware without saggers, and (2) a better use of the firing space. The difficulties arising during firing in a circular kiln, *e.g.*, coloring of the ware, overfiring, and underfiring, do not exist in electric kilns. The temperature is regulated automatically or by means of thermoelements, making the care of the kiln simple. Fewer workers are required and the operation of the kiln is much cleaner. The costs of operating these two kinds of kilns are given. M.V.K.

German petroleum. G. BAUM. *Brennstoff-Chem.*, **13** [3], 49–53 (1932).—A survey of the German mineral oil industry is presented. The location of the petroleum fields and the refineries is given together with figures for the total oil production in 1929 and the first half of 1930. A history of the development of the German petroleum industry is included. Illustrated. J.L.G.

Bituminous peat. I. Fatty acids. EUGEN W. RAKOWSKI AND N. G. EDELSTEIN. *Brennstoff-Chem.*, **13** [3], 46–49 (1932).—The alcohol-benzol extract of a bituminous peat gave 33% resin from which 54.5% of crude resinous acid was obtained from the resinous portion. From the waxy part of the bitumen (13%), 57% of crude fatty acids were separated or 7.4% of the total bitumen was fatty acid. The remainder of the waxy part of the bitumen consisted of esters and nonsaponifiable substances. The acids $C_{26}H_{52}O_2$, $C_{27}H_{54}O_2$, and $C_{28}H_{56}O_2$ were separated from the crude fatty acids. J.L.G.

Sun rays captured by chemists for high-temperature research. ANON. *Chemicals*, **36** [26], 12 (1931).—Recent experiments on the concentration of solar energy have demonstrated that temperatures above 3000°C may be obtained. Zirconium oxide has been melted by this means. This energy is in an ideal form for handling because it is entirely radiant, uniform in quality, and unassociated with fuel gases of electrical conductors. The factor that overshadows all others in high-temperature research is the progressive failure of all materials of construction. The modes of failure are of four types, (1) decomposition or alteration, (2) oxidation, (3) fracture of flow, and (4) fusion. Various methods of generating heat for laboratory experiments are briefly outlined. See also *Ceram. Abs.*, **10** [9], 631 (1931). G.R.S.

BOOK AND CIRCULAR

Regenerators, Recuperators, and Air Heaters. Vol. V. (Regeneratoren, Rekuperatoren, Winderhitzer.) WERNER HEILIGENSTAEDT. Published by Otto Spamer, Leipzig, 1931. 345 pp. Reviewed in *Chem. Met. Eng.*, **39** [2], 96 (1932).—This volume is the fifth of a series on industrial furnaces. The numerous charts and tables greatly reduce the labor of calculation. G.R.S.

Physical-chemical properties of methane. H. H. STORCH. Bur. Mines, *Information Circ.*, No. 6549. 14 pp. (Free.) A brief critical review of important data on the physical-chemical properties of methane is designed to act as an introduction to further research on the utilization of natural gas. R.A.H.

PATENTS

Tunnel kiln car and refractory slag therefor. ROGER W. ROWLAND. U. S. 1,846,614, Feb. 23, 1932.

Tunnel kilns. F. M. HARTFORD AND S. M. KIER. Brit. 365,614, Feb. 3, 1932.

Electrical nonmetallic resistors. GLOBAR CORP. Brit. 366,605, Feb. 17, 1932.

Geology

Structural formula of hydromagnesite. G. R. LEVI AND D. GHIRON. *Giorn. chim. ind. applicata*, **13** [9], 438 (1931).—The existence of a single basic carbonate of magnesia which is identified with hydromagnesite was recently confirmed by Menzel and Brickner. The formula of this carbonate is $5MgO{\cdot}4CO_2$ aqueous rather than $4MgO{\cdot}3CO_2$ aqueous determined by Levi and accepted by many authorities. In relation to this disagreement between the two formulas the authors examined natural magnesites of different origin in order to determine the formula of the mineral. The four types of hydromagnesite were examined and the results obtained are described. M.V.K.

Dehydration, soil acidity, and exchangeable bases. H. G. COLES AND C. G. T. MORISON. *Soil Sci.*, **33** [2], 115–24 (1932). G.R.S.

Equilibria of the base-exchange reactions of bentonites, permutites, soil colloids, and zeolites. A. P. VANSELOW. *Soil Sci.*, **33** [2], 95–113 (1932). G.R.S.

Classification of and specifications for siliceous sands. RALPH TUCK. *Econ. Geol.; Rock Prod.*, **34** [14], 45 (1931).—This abstract contains in a very few words a great deal

of information about sand requirements for various uses. Uniformity of grain size and clay content are used as a means of classifying sands as to their uses. W.W.M.

Boron and its compounds. R. M. SANTMYERS. *Rock Prod.*, **34** [21], 73 (1931); for abstract see *Ceram. Abs.*, **11** [1], 56 (1932). W.W.M.

Perthites. H. L. ALLING. *Amer. Mineralogist*, **17** [2], 43–65 (1932).—No one theory of the origin of perthitic feldspars is adequate because there are several processes capable of forming these intergrowths. Vogt's 1926 thermal diagrams are discussed. His diagrams showing a series of solid solutions with a minimum of inclined solubility curves, even though they do not show polymorphism, are as satisfactory as any. A classification of perthites is offered on a temperature basis, using terms of Makinen and Anderson. The nomenclature of perthites is outlined with suggestions for more specific terminology. G.R.S.

Origin of the talc and soapstone deposits of Virginia. J. D. BURFOOT, JR. *Econ. Geol.*, **25**, 805–26 (1930).—The geographic distribution of these deposits is discussed, and their characteristics are described. The presence or absence of talc, soapstone, or steatite in this region is thought to depend, in part at least, on the occurrence of the correct segregation product, *i.e.*, pyroxenites, peridotites, or dunites, on the presence of feeding channels leading to these rocks, and on the invasion of the correct type of solutions, *i.e.*, solutions of the correct chemical character with the requisite temperature and pressure. The condition of differential stress is not necessary for the formation of talc. The mineral association and paragenesis seem to indicate that talc is formed under deep or intermediate vein zone conditions. (*C.A.*)

Origin of the white clays of Tuscaloosa age (Upper Cretaceous) in Alabama, Georgia, and South Carolina. GEORGE I. ADAMS. *Econ. Geol.*, **25**, 621–26 (1930).—A. believes that the white clays in the district were not the result of marine deposition, as held by Newmann. Deposition of clayey material in small shallow fresh-water lakes is more commensurate with the extent of the white clay bodies, but does not explain the massive character of the beds. It is suggested that the massive character and purity of the clay are the result of the local alteration of deposits of impure clays. No attempt is made to explain the chemical processes which are involved. A satisfactory explanation must be applicable to all the white clays in the region which are similar in character, whether their sources were the crystallines and metamorphics, or the sedimentary areas, and whether they occur in the Tuscaloosa or other formations. (*C.A.*)

Genesis of the emery deposits near Peekskill, New York. JOSEPH L. GILLSON AND JOSEPH E. A. KANIA. *Econ. Geol.*, **25**, 506–27 (1930).—These deposits, still mined on a small scale, are located 35 mi. north of N. Y. City on the east bank of the Hudson, along and on both sides of the contact of the Manhattan schist and Cortlandt intrusives. G. and K. present data disproving the assimilation theory of the deposits and proving that they are contact-metamorphic in origin and were formed by gaseous or liquid emanations from the magma reservoir which passed upward through the already solid border of the igneous mass and into the schist. A detailed mineralogical and petrographical description of the rocks and ores is given. (*C.A.*)

Clays of the Jackson Purchase region, Kentucky. JOSEPH K. ROBERTS. *Econ. Geol.*, **25**, 832–36 (1930).—The geological formations of this region range from the limestone and chert of Mississippian to the recent surficial deposits. Detailed descriptions are given of a number of the clays. Tables of chemical analyses are included. (*C.A.*)

Geology of some kaolins of western Europe. ERNEST R. LILLEY. *Mining & Met.*, **13** [303], 9–10 (1932).—In addition to residual kaolins from pegmatites and to sedimentary clays similar to those of the south Atlantic states, the three following types of deposits of economic importance are found in western Europe: (1) blanket residual

kaolins in the granites and related crystalline rocks of southern Germany and Czechoslovakia, (2) kaolinized arkosic sandstones of Czechoslovakia and Bavaria, and (3) china clay and china stone in the granite of Cornwall, England. These kaolins and methods of mining and refining of each are described. E.J.V.

China clay (kaolin). ANON. *Chem. News*, **144** [3746], 73–74 (1932).—The uses of kaolin are outlined. The output of kaolin in 1930 for different countries is given. G.R.S.

Bentonite from Ventura, California. PAUL F. KERR. *Econ. Geol.*, **26**, 153–68 (1931).—The light green soapy clay occurs in the Miocene stratum of the Ventura quadrangle at the base of the Modelo formation and overlies the top of the Rincon formation. Relict structures observed in thin sections show that the clay is bentonite. The essential constituent is montmorillonite. The chemical analysis and X-ray diffraction data are given. (*C.A.*)

Grinding Buckingham feldspar. W. C. ROWE. *Can. Mining Jour.*, **52**, 613–15 (1931).—A brief, illustrated description of the feldspar-grinding plant of the Canadian Flint & Spar Co., Ltd., is given. (*C.A.*)

Magnesite in South Africa. ANON. *Internat. Bull. Refrig.*, **12**, 323 (1931).—There are important deposits in the Transvaal containing 90% magnesite and 5% silica. Export is at present only small. H.H.S.

BOOKS AND BULLETINS

Textbook of Microscopy of the Ore Minerals. (Lehrbuch der Erzmikroskopie.) HANS SCHNEIDERHOHN AND PAUL RAMDOHR. Published by Gebruder Borntraeger, Berlin, 1931. Price $17.50. Reviewed in *Amer. Mineralogist*, **17** [2], 79–83 (1932).—This monumental work on the microscopic study of the ore minerals in vertically reflected light is to comprise two volumes and an appendix consisting of determinative tables for ore minerals. At present, only Vol. II (to which this review applies) and the appendix have come off the press. Volume II is a description of ore minerals and the microscopic properties. The data for each mineral have been arranged in a definite sequence and since in the past no definite system has been followed the authors suggest that in the future others follow the same plan they have used. The scheme is given in detail. See following abstract.

Determinative Tables for Microscopy of the Ore Minerals. (Erzmikroskopischen Bestimmungstafeln.) **Appendix to Textbook of Microscopy of the Ore Minerals.** H. SCHNEIDERHOHN AND P. RAMDOHR. Gebruder Borntraeger, Berlin, 1931. 46 pp. Reviewed in *Amer. Mineralogist*, **17** [2], 83–84 (1932).—Minerals in this table are arranged in accordance with their qualitative and not quantitative characteristics. The only quantitative data used are the relative reflective values for the minerals. The principal properties on which minerals are arranged are (1) hardness, (2) behavior toward polarized light, and (3) color. G.R.S.

Microscopic Characters of Artificial Inorganic Solid Substances or Artificial Minerals. ALEXANDER NEWTON WINCHELL. Published by John Wiley and Sons, Inc., N. Y. Reviewed in *Rock Prod.*, **35** [3], 60 (1932).—The microscopic character of artificial minerals is thoroughly covered and the volume should be valuable to cement or ceramic engineers interested in the microscopic study of Portland cements or similar artificial mineral compounds. W.W.M.

Systematic Crystallography: An Essay on Crystal Description, Classification, and Identification. T. V. BARKER. *Jour. West. Soc. Eng.*, **37** [1], 52 (1932); for abstract see *Ceram. Abs.*, **10** [7], 522 (1931). W.W.M.

Lawrence Clay of Lawrence County, Ohio. G. A. BOLE, MYRIL C. SHAW, AND WILBER STOUT. O. S. U. Engineering Expt. Sta., *Bull.*, No. 67, 134 pp. (March, 1932).—The

Lawrence clay is a ceramic asset to the State. The clays in this section include both flint and plastic, the latter kind forming the main body of the deposits. The plastic clay is of two classes, the aluminous plastic or "cream" clay and the siliceous plastic clay. Data of detailed sections of clays in the Lawrence field, the Dean field, the Firebrick field, and some outlying areas include the following information: (1) geologic deposition, (2) chemical analysis, (3) physical properties, (4) dry and fired properties, and (5) application for ceramic products. The utilization and possibilities of the Lawrence clay are considered more specifically under the following heads: terra cotta, bond clays for general uses, foundry uses, in saggers, plastic refractories, fireclay mortars and high-temperature cements, refractories, sewer pipe and allied products, sanitary and decorative tiling, quarry and promenade tile, face brick, salt-glazed and enameled brick, yellow ware and related products, stoneware, sanitary ware, tableware, cooking and serving ware, conduits, fireproofing, and crucibles. The methods of tests are described. Illustrated. E.J.V.

Volynites (Basalts of Volyne). S. NASAREVITCH, L. KRYJANOVSKY, G. BYVEL, AND Y. GUROVITCH. *Trans. Kiev Div. Ukrainian Sci. Research Inst. Silicate Ind.* [U.S.S.R.], Vol. 9, 36 pp. (1931).—This volume is divided into three sections: (1) general by N., (2) geological by K., and (3) technological by B. and G. The main constituents of Volynites are feldspar (plagioclase), augite, hornblende, and titanous iron. The chemical composition of Volynites compared with French basalt (Société du Basalte, Overn) is as follows:

	Volynites (average of 10 samples)	French basalt
SiO_2	51.42–55.20%	42.06%
TiO_2	2.15– 3.18	
FeO_3 + FeO	13.47–16.71	6.40 (Fe_2O_3)
FeO		7.75
Al_2O_3	10.16–17.72	15.99
CaO	3.32– 9.74	11.09
MgO	0.09– 2.53	10.15
K_2O	2.70– 9.57	1.66
Na_2O	1.39– 3.37	3.47
Ignition loss		0.97

NOTE: A. B. Searle (see Encylcopedia of Ceramic Industries, Vol. 1, p. 59) gives the following definition: "Basalt—a kind of natural glass of volcanic origin usually low in alkalis but rich in lime, alumina, and iron (ferrous) oxide. Its melting point is usually between Seger cones 9, 8, and 14. Its composition is variable. It is occasionally used as a substitute for feldspar or other flux when a dark-colored ware or glaze is being produced."

Attempts have been made (1) to use Volynites as a cheap material for making black glass articles, (2) to use them as coloring agents for making colored glasses and glazes, and (3) to find the optimum conditions of crystallization of Volynites to be used for making high- and low-voltage insulators. Experimental melts of pure Volynites and of mixtures of Volynites with additions were made in a grog crucible fired in an oil pot furnace. The weight of the batches was 33 to 48 kg. To study the coloring action of Volynites a batch of the following composition was taken: 30 kg. sand, 11 kg. soda ash, 5 kg. chalk, and 0.25 kg. salt cake. To this batch were added, successively, 2.5 kg. powdered natural basalt, 2.5 kg. powdered melted basalt, and 7.5 kg. powdered natural basalt. The glasses obtained had two colors, fine emerald and dark green. The study of crystallization was carried out in a laboratory electrical furnace. Conclusions are as follows: (1) The presence of a great quantity of alkalis has a good influence on the conditions of melting of basalt as they lower the melting point. (2) Because of the high content of alumina in the basalts the glasses obtained have a good hardness, thermal and mechanical strength, and chemical stability to acids and alkalis. (3) Owing to the high

content of FeO and Fe_2O_3 the glasses are completely black and nontransparent. (4) The melting point of basalt is 1200 to 1250°C. (5) The melted basalt can be pressed. (6) The melted basalt cannot be blown out without additions (soda ash, chalk, etc.). (7) The working temperature is 1300 to 1500°C. (8) The rate of melting and the quality of glass do not depend on the fineness of grind of basalt. (9) In all the experimental melts devitrification was not observed. (10) The addition of 6.6% soda ash or 3.3% chalk to the weight of Volynites lowers the viscosity of glass to such a degree that it may be blown out. Satisfactory bottles have been prepared from the molten glass. (11) Basalt can be used to obtain colored glasses, *i.e.*, green, dark green, and black. (12) The Volynites attack glass pots vigorously, especially the bottom, and therefore one pot served only 4 or 5 melts. (13) The melted basalt can be cut well with natural sandstones and polished on cork wheels. (14) Microscopical investigations showed that in most of the tested samples over 50% of the whole mass had been crystallized. See also *Ceram. Abs.*, **10** [11], 788 (1931). S.I.P.

China Clay. Its Trade Classification and Uses. ANON. Published by the Mineral Resources Bureau of the Imperial Inst. 100 pp. Price 1s 6d. Reviewed in *Chem. Trade Jour.*, **90** [2331], 81–82 (1932).—Details are given as to production, trade classification, utilization, prices, and detailed figures for all the countries of the world producing china clay. M.V.K.

Geophysical Abstracts. XXXIII. F. W. LEE. Bur. Mines, *Information Circ.*, No. 6593. 23 pp. (Free.) A review is given of recently published articles, books, and patents on geophysical methods of prospecting. For Part XXXII see *Ceram. Abs.*, **11** [4], 267 (1932). See following abstract. R.A.H.

Index to Geophysical Abstracts, Numbers 21 to 32. PALMER LARSEN. Bur. Mines, *Information Circ.*, No. 6589. 34 pp. R.A.H.

Chemistry and Physics

An experimental investigation of the phase relations of $K_2Si_4O_9$ under pressure. R. W. GORANSON AND F. C. KRACEK. *Jour. Phys. Chem.*, **36** [3], 913–26 (1932).—The phase relations of $K_2Si_4O_9$ were investigated experimentally to 3000 bars pressure (metric atmospheres). Results are tabulated as follows: densities at 25°C, crystals 2.335, glass 2.384; inversion curve, 592°C at atmospheric pressure; heat of transition 9.6 joules per gram (2.3 cal.); $dt/dp = 28°$ per 1000 bars. The calculated volume change on inversion, low $\longrightarrow$ high, is $+0.003$ cm.^{3}/g. These values are similar to the quartz inversion. $K_2Si_4O_9$ melts congruently at 765°C at atmospheric pressure and the heat of melting is 146.5 joules per gram (35 cal.). The initial slope of the pressure-melting curve is $-60°$ per 1000 bars, *i.e.*, an increase of pressure lowers the melting temperature at the rate of 60° for each kilobar increase in pressure. This boundary curve was realized experimentally to 3000 bars. The following phase equilibria relations were obtained indirectly: (1) Above 140 bars pressure $K_2Si_4O_9$ melting becomes incongruent and the compound breaks up into quartz and liquid. (2) Above 1250 bars, $K_2Si_4O_9$ can no longer exist in equilibrium with liquid; instead, quartz and $K_2Si_2O_5$ form a simple eutectic. Further, since the reaction, quartz + $K_2Si_2O_5 \rightleftharpoons K_2Si_4O_9$, probably cannot be realized in practice, the presence of crystalline $K_2Si_4O_9$ in a mixture of unknown origin would indicate that the silicate solution has crystallized below about 1250 bars pressure. The density of crystals of $K_2Si_2O_5$ at 25°C is 2.538, of glass at 25°C, 2.474. The melting temperature is raised about 3.5°C for each kilobar rise in pressure. G.R.S.

Comparison of 2% citric acid and neutral ammonium citrate solutions as solvents for phosphates. K. D. JACOB, L. F. RADER, JR., AND W. H. ROSS. *Jour. Assn. Official Agric. Chem.*, **15** [1], 146–61 (1932).—The results of a study of the solubility of 87

samples of various phosphatic materials in 2% citric acid and neutral ammonium phosphate are presented. J.L.G.

Detection of iron. F. FEIGL AND H. HAMBURG. *Z. anal. Chem.*, **86**, 7–13 (1931); *Sprechsaal*, **65** [4], 65 (1932).—Although the detection of iron by means of the Berlin blue reaction and the thiocyanogen reaction is sensitive, it was found impossible to determine iron with these reagents when the concentration of ferric ions is low. The use of α and α'-dipyridyl is recommended. With this composition, the ferrous ion produces a ferrous dipyridyl ion of an intensive red color which is completely stable. Iron (3) salts do not react with the reagent. With the help of α and α'-dipyridyl (2% HCl solution) it is possible to detect 0.03μ ferrous ion by means of the spot reaction through the pink coloring. The method is well adapted for detecting iron (2) in the presence of iron (3) compounds. When fluorides are tested for iron, 1 cc. of the solution to be investigated is treated with several drops of ammonium sulphide in a paraffin-porcelain crucible to which some of the reagent solution is added. The detection of Fe in technical samples is described, and the preparation of α and α'-dipyridyl according to F. Hein and W. Retter is given. M.V.K.

Reaction between barium sulphate and alumina at high temperatures. H. S. BOOTH AND R. WARD. *Jour. Phys. Chem.*, **36** [3], 961–84 (1932).—Reaction between $BaSO_4$ and Al_2O_3 takes place appreciably at temperatures above 1000°C. The rate of reaction increases with increasing proportions of Al_2O_3 in the mixture, but it will not go to completion below 1238°C. The temperature at which rapid reaction sets in is close to that at which γ-Al_2O_3 changes to corundum. The percentage of barium rendered soluble is not always a true measure of the decomposition attained. When the reaction mixture contains an excess of Al_2O_3, some of the barium aluminate forms with it a solid solution which is insoluble in HCl. The reaction product at temperatures between 1000 and 1440°C is monobarium aluminate, $BaO{\cdot}Al_2O_3$. No evidence of the formation of tribarium aluminate was obtained. Monobarium aluminate is water soluble and sulphur free and may be used in the production of pure barium compounds. The mechanism of the reaction is outlined. G.R.S.

Detection of tin in glasses without previous decomposition of silicates and thermoluminescences of different tin compounds. JOSEPH HOFFMANN. *Sprechsaal*, **65** [5], 82–83 (1932).—H. discusses (1) the behavior of tin glasses and different tin compounds exposed to ultra-violet rays, (2) thermoluminescence phenomena of which tin present in glass permits the detection without previous treatment with hydrofluoric acid because of conversion into tin hydride, and (3) the possibility of determining natural rocks containing tin in the same manner.

Samples	Coloring	Fluorescences	
		Unfiltered ultra-violet	With blue filter
$SnCl_2{\cdot}H_2O$	white		brown
	colorless solution		yellow tinged
$2SnO{\cdot}H_2O$	white		red-violet
$SnO{\cdot}NaH$	colorless solution		weak violet
$(SnO_2H_2)_4$	white		peach blossom
Cassiterite (SnO_2)	brownish		brown
C.P. SnO_2	white		yellow-brown
Soda and saltpeter tin extraction	white		brownish
Glasses with stannous chloride	small pieces colorless, larger pieces bluish		milky, yellow-green, yellow tinged
Tin water glasses	yellow tinged		brownish
Tin enamel	white	yellow-brown	brownish

M.V.K.

Catalytic reaction between tin dioxide and lime. S. TAMARU AND N. ANDO. *Jour. Chem. Soc.* [Japan] **52**, 36–46 (1931); *Sprechsaal*, **64** [48], 892 (1931).—CaO and SnO_2 react between 900 and 1000° only in the presence of catalyzers (H, C, CO, S, Zn, SnO, and reduced organic vapors). The optimal requirements for a reaction are (1) the proportion of 1 mol SnO_2:7 mol CaO with 0.05 mol H or C at 900°, (2) heating time 1 hr., and (3) presence of water. The curves for the catalytic action and for the reduction are similar so that the authors assume that the first stage of the catalysis takes place in an intermediate reduction. With catalyzers as C which do not form water as a reducing product, no reaction takes place; with other substances which form water, the reaction takes place. The quantity of the reaction product is proportional to the logarithm of the length of heating and the CaO quantity present. The reactive surface of the latter is often of important influence. M.V.K.

Silicate structures of the cristobalite type. I. The crystal structure of α-carnegieite ($NaAlSiO_4$). T. F. W. BARTH AND E. POSNJAK. *Z. Krist.*, **81** [1–2], 135–41 (1932).—X-ray powder diffraction was obtained from α-carnegieite at 750 and 770°C. The length of the edge of the unit cube, comprising four molecules of $NaAlSiO_4$, was found to be 7.37Å; calculated density, 2.343 at 750°C. The space group is $P2_13(T^4)$ and the atomic positions are as follows: Na, Al, and Si in (4*f*) with parameter values 268, 93, and 0°, respectively; 4 of the 16 oxygen ions in (4*f*) with a parameter value of 45°, and the rest of the oxygen ions in the twelve general positions of $P2_13$ with parameter values as follows: $x = 237°$, $y = 232°$, $z = 20°$. G.R.S.

Properties of silica remaining after the attack of leucite by acids. G. A. BLANC. *Giorn. chim. ind. applicata*, **13** [9], 425 (1931).—In his work on the use of leucite as a source of alumina and potash, B. describes the method of liberating the solutions from the silica in colloidal suspension, using the same silica separated in the attack. The phenomenon is interpreted as the separation of a dispersed phase from the circulating dispersoid. M.V.K.

Silicate chemistry. ANON. *Sprechsaal*, **65** [8], 140 (1932).—A review is made of the important American researches in the field of silicate chemistry from 1927–30, inclusive. Quartz, silicate systems, and glass are discussed. M.V.K.

Analysis of aluminum sulphate. W. D. BANCROFT, H. L. DAVIS, AND ESTHER C. FARNHAM. *Jour. Phys. Chem.*, **36** [2], 515–22 (1932).—An investigation was made of the errors which occur in the precipitation of barium sulphate from solutions of ferric and aluminum sulphates. In the case of ferric sulphate, large errors arise from the adsorption of sulphate ions on the hydrous ferric oxide resulting from hydrolysis. Another error is due to the retention of a protected barium sulphate in colloidal solution. The lower degree of hydrolysis of aluminum salts minimizes both these errors. Aluminum chloride in the precipitation of barium sulphate involves not more than 0.7% error as contrasted with 10% error in iron solutions. Water from hydrated aluminum sulphate may be removed almost completely by heating to 400 to 500°C without significant loss of SO_3. The anhydrous salt can then be decomposed to alumina over the blast lamp. Such determinations of water, SO_3, and Al_2O_3 by thermal decomposition agree well with the values obtained by precipitation methods. G.R.S.

Titration curves for aluminum salts with alkalis. H. L. DAVIS AND ESTHER C. FARNHAM. *Jour. Phys. Chem.*, **36** [3], 1057–74 (1932).—The titration curves of Hildebrand for aluminum sulphate and of Blum for aluminum chloride were repeated and the general features of the curves confirmed except insofar as the earlier work was done on salt which contained free acid. It is evident that the interpretations previously offered are not valid. The breaks in the curves are not unique for alumina alone but are influenced by the conditions. Aluminum salts can be titrated with alkali if boiled, and salt addition is not necessary and is, in some cases, bad practice. It is shown that alumi-

num salts cannot be titrated cold by adding sufficient alkali to bring the system to p_H 7 as was believed. The volumes of alkali used for this and for the break in the curves at p_H 10 to 11 are not in the simple ratio of 3 and 4 NaOH per atomic weight of aluminum and therefore lose all value as a proof of compound formation in the excess alkali. Alumina deposited on the hydrogen electrode can cause large errors in the readings obtained. G.R.S.

The ternary system: sodium silicate–ferric oxide–silica. N. L. BOWEN, J. F. SCHAIRER, AND H. W. V. WILLEMS. *Amer. Jour. Sci.*, **20** [5], 405–55 (1930).—A study of the crystallization equilibrium in the system $Na_2O{\cdot}SiO_2$–Fe_2O_3–SiO_2, obtained by the quenching method, is presented in detail. The equilibrium diagrams show the existence of 2 ternary compounds whose compositions lie within the triangle: acmite ($Na_2O{\cdot}Fe_2O_3{\cdot}4SiO_2$) and a new hexagonal compound ($5Na_2O{\cdot}Fe_2O_3{\cdot}8SiO_2$). A third compound ($6Na_2O{\cdot}4Fe_2O_3{\cdot}5SiO_2$) lies outside the triangle but overlaps somewhat with its field. Acmite melts incongruently with separation of hematite at 990°; the new hexagonal compound melts congruently at 838°. Because of the incongruent melting of acmite there result some very interesting crystallization courses in mixtures rich in acmite. In certain mixtures hematite may be crystallized, react with liquid, and recrystallize. This introduces markedly different alternative courses of crystallization from the same original liquid. With strong fractionation the final liquid attains the lowermost eutectic, at which acmite, Na disilicate, and quartz are formed. A discussion is given of the application of these results to petrology. Volatile components are not necessary for quartz crystallization. The production of an Fe-rich residual liquid during crystallization of basaltic magma under certain conditions is no bar to the production of a siliceous-alkalic residual under other conditions. (*C.A.*)

The system MgO–FeO–Fe_2O_3 in air at one atmosphere. H. S. ROBERTS AND H. E. MERWIN. *Sprechsaal*, **64** [39], 719 (1931); for abstract see *Ceram. Abs.*, **11** [3], 202 (1932). M.V.K.

Hydrogels. VI. Conversion of water of hydration into water of adsorption by mechanical grinding of crystalline hydrates. A. SIMON AND O. FISCHER. *Z. anorg. allgem. Chem.*, **185**, 101–106 (1929).—A sample of $Al_2O_3{\cdot}3H_2O$ was ground under water to colloidal dimensions. After this treatment, the chemical composition of the sample became $Al_2O_3{\cdot}2.78H_2O$. The change was probably caused by local heating. The isobaric curves of dehydration show the treated and untreated samples to be identical. It is concluded that mechanical grinding does not modify the state of the water of crystallization. **VII. Chromium oxide hydrates.** A. SIMON, O. FISCHER, AND TH. SCHMIDT. *Ibid.*, 107–29.—Hydrated Cr_2O_3 samples were prepared by various methods, and their isobaric curve of dehydration was measured. A monohydrate and possibly a trihydrate were detected in specimens obtained by slow precipitation in the cold from dilute solutions; X-rays show definite lines only when these specimens are heated for a long period of time with water under pressure. It is postulated that water is more firmly combined in samples obtained in the cold than in samples obtained from hot solutions. The precipitation and solution of samples of different ages show that freshly precipitated samples are amorphous and retain water only by capillarity. "Aging" is a gradual transformation into a monohydrate, and then, possibly into a trihydrate. Specimens slowly aggregated are "older" than specimens rapidly aggregated. **VIII. Zirconium dioxide hydrates.** A. SIMON AND O. FISCHER. *Ibid.*, 130–43.—Experiments similar to those done with Cr_2O_3 were repeated with ZrO_2. No definite hydrate was observed, Despite differences in the preparation and aging of the samples, they were found to be identical. **IX. Lead dioxide hydrates.** A. SIMON. *Ibid.*, 280–99.—The following preparations were made: A – $PbO_2{\cdot}1.24H_2O$, H_1 – $PbO_2{\cdot}0.32H_2O$, H_2 – $PbO_2{\cdot}0.36H_2O$, H_3 – $PbO_2{\cdot}0.44H_2O$, P_1 – $PbO_2{\cdot}0.84H_2O$, P_2 – $PbO_2{\cdot}0.88H_2O$, P_3 – $PbO_2{\cdot}0.82H_2O$.

The preparations were subjected to isobaric decomposition. The substances are certainly colloids, no indication of the existence of definite hydrates being obtained. Calculation of the constant k in the equation for vapor pressure curves, in $(p_0/p) = k/n$, gave for preparation A these values: at 25° 0.97, at 53° 1.04, at 126° 1.01, at 169° 0.79, at 232° 0.29. The rapid fall above 126° is due to the rapid aging at higher temperatures, the osmotic system going over to PbO_2 and free H_2O. Heats of formation are given for preparation A as follows: at 25° 13,360 cal., at 42° 14,720 cal., at 126° 18,290 cal., at 232° 23,600 cal. Examined under the ultramicroscope, H_1 strongly aged by boiling showed little Brownian motion, but K_2 under the same conditions showed it strongly. The P preparations all went largely into solution as sols and showed strong evidence of Brownian motion. Particularly beautiful sols were obtained with alcohol, the dispersion being so fine that only very slight Tyndall effects were obtained. The P preparations were examined röntgenographically; hardly any lines were obtained except after the decomposition. The Debye diagrams confirm the fact that the H_2O is combined osmotically rather than chemically. Of extraordinary importance is the fact that the lines present are identical with those of crystalline PbO_2, from which it follows that the stable end condition of the PbO_2 hydrates is to be sought in the crystalline anhydrous form. Aging experiments also show that H_2O tends to become less firmly held (behavior similar to that found with Si, Th, Ti, Zr, Sn, and Mn) the end condition being in all cases anhydrous dioxide. (*C.A.*)

Analysis of Kukkerseit from its specific gravity. D. VON ENGELHARDT. *Brennstoff-Chem.*, **13** [1], 10–11 (1932).—Chemical analyses and specific gravity determinations on 66 different samples of Kukkerseit, an oil shale of northern Esthonia, show that the specific gravity is essentially a function of the content of organic matter. If the analysis is known the specific gravity can be predicted and, conversely, if the specific gravity is known the content in organic matter can be calculated without resorting to actual analysis. The results secured, while not quite as accurate as actual analysis, have the advantage of a great saving in time. J.L.G.

Studies on the zeolites. I. General review. MAX H. HEY. *Mineralog. Mag.*, **22**, 422–37 (1930).—A review is given of the general characteristics of the zeolites and their relations to other groups of minerals and to certain artificial products, preparatory to a detailed examination of the various species. A bibliography is given. (*C.A.*)

Crystal structure of Skapolith. E. SCHIEBOLD AND G. SEUMEL. *Z. Krist.*, **81**, [1–2], 110–34 (1932).—Skapoliths are compounds of the type $3Na{\cdot}AlSi_3O_8{\cdot}NaCl$. The constants of Skapoliths from Arendal and Mt. Somma were determined to be $a_0 = 12.09 \pm 0.006$Å, $c_0 = 7.580 \pm 0.004$Å, and $a_0 = 17.24 \pm 0.015$Å, $c_0 = 7.619 \pm 0.006$Å, respectively. The unit cell contains two molecules of Skapolith. The space group is probably C_{4h}^5, though C_4^5 and S_4^2 are also possible. A theoretical discussion of the results is given. W.M.C.

Experiments on the cohesion of quartz fibers. G. A. TOMLINSON. *Sprechsaal*, **64**, [9], 170 (1931); for abstract see *Ceram. Abs.*, **10** [12], 828 (1931). M.V.K.

Rhenium. W. F. MEGGERS. *Sci. Monthly*, **33**, 413–18 (1931).—Discovered in 1925 by Noddack, Re is comparatively so abundant that an annual production of 120 kg. from one chemical plant is announced. Its melting point is $3440 \pm 60°$ absolute. H.H.S.

Estimation of free calcium oxide and hydroxide. ANON. *Chem. News*, **144** [3747], 93 (1932).—The content is given of a report on the methods of determining the amounts of hydrated and unhydrated free lime. G.R.S.

Studies on silicic acid gels. I. Measurements on surface tension during setting and the effect of temperature on the time of set. C. B. HURD AND H. A. LETTERON. *Jour. Phys. Chem.*, **36** [2], 604–15 (1932).—A study was made on the variation of surface

tension of a mixture of solutions of sodium silicate and acetic acid during the process of gelation. The reading on a du Nouy apparatus remained almost constant until the mass was about to set, when it rose rapidly. A picture of a slow process followed by a rapid process was suggested. A satisfactory test for the time of set was devised and the effect of temperature on the time of set of several mixtures was determined. By making several assumptions the value of Q in Arrhenius' equation was calculated. G.R.S.

Present position of the theory of the coagulation of dilute clay suspensions. A résumé. E. W. RUSSELL. *Jour. Agric. Sci.*, **22** [1], 165–99 (1932).—R. reviews the present knowledge of the coagulation of dilute clay suspensions in the light of the electrical theory of colloidal behavior and appends an extensive bibliography. Two mechanisms causing collisions between suspended particles are considered, *viz.*, the Brownian movement and the mass motion of one group of particles relative to another group. The rate of coagulation of a suspension is shown to depend on the rate of collision between particles and on the probability of adhesion when they collide. The theory of the electrokinetic potential of suspended particles and the method of determining it from mobility data are discussed. The influence of electrolytes and nonelectrolytes on the stability and on the electrokinetic potential of solutions is discussed and evidence in favor of the critical potential is reviewed. The influence on the stability of a clay suspension of the type and total amount of ions held by the clay is discussed as well as the rapid flocculation clay suspensions can undergo in alkaline media. These properties are satisfactorily explained by the electrical theory developed by R. when the secondary chemical reactions occurring are taken into account. The upper limit of the clay concentration in the clay suspensions discussed is 0.1%. J.L.G.

Concentration of cations in clay sols. RICHARD BRADFIELD. *Jour. Phys. Chem.*, **36** [1], 340–47 (1932).—The concentration of cations at the surface of colloidal clay particles is higher than in the intermicellar liquid in a carefully purified system. The concentration of Ca and Ba ions in such purified clays is of about the same order of magnitude as in such insoluble salts, and liberates from them quantities of anions of the same order of magnitude as are supplied in ordinary fertilizer practice. G.R.S.

Water relationships in colloids. II. "Bound" water in colloids. D. R. BRIGGS. *Jour. Phys. Chem.*, **36** [1], 367–86 (1932).—A theoretical basis for "bound" water determinations in colloid systems is outlined in terms of the relative vapor-pressure water-content curve (vapor-pressure isotherm) of the colloid. Bound water is defined as that portion of the water in a system containing colloid and crystalloid which is associated with the colloid together with those ions which form a part of the colloid complex. Bound water is not a fixed quantity of water associated with the colloid but will vary with the activity of the water in the system in a manner consistent with the vapor-pressure isotherm of the colloid. Some methods used for the determination of bound water are interpreted. For Part I see *Ceram. Abs.*, **10** [12], 862 (1931). G.R.S.

Dimensional analysis of plastic flow. M. D. HERSEY. *Jour. Rheol.*, **3** [1], 23–29 (1932).—The dimensional analysis of plastic flow proposed in this paper offers hope for future attack on the problems of turbulent motion in plastic materials. Two equations which H. has found useful are investigated. G.R.S.

Effect of aqueous solutions on colloidal powders. J. L. SHERESHEFSKY. *Jour. Phys. Chem.*, **36** [2], 696–702 (1932).—Methods of measuring rate of sorption of colloidal powders are reviewed and the construction of a volumetric sorptometer is described. The effect of solutions of sodium chloride and magnesium chloride on the rate of sorption of Jackson shale is determined. The mechanism of sorption of colloidal powders is discussed. G.R.S.

Some observations on the reactions of kaolins and clays on drying. R. RIEKE AND J. GIETH. *Ber. deut. keram. Ges.*, **12** [11], 556–95(1931).—The authors studied the re-

lation of (1) water of plasticity, (2) shrinkage water, (3) shrinkage in drying and firing, and (4) porosity (dried and fired) in a variety of clays having varying fineness and varying rates of drying and firing. They also made measurements of hygroscopicity and plasticity. Hygroscopicity, moistness in an air-dry condition, and plasticity according to Rieke and Bigot give the same order for all raw materials. It is shown that the tempering water of a clay is no measure for the degree of plasticity. Experiments on drying curves and linear and volume shrinkage were made. Tests on moist clay bodies showed a volume greater than the calculated sum of the volume of the dry clay and the water content. For some raw materials this increase amounts to over 3% and is traced to finely divided air bubbles. For the purpose of studying the movement of moisture from the interior of a moist clay to the surface, the moist body was rolled out in a cylinder, placed in a measuring cylinder which was open only on a front side, and dried. The results plotted in a curve show that the drying of the clay is slower if (1) the time curve followed is steeper, *i.e.*, the quantity of water evaporated hourly is less (this is greater if the pore water determined from the beginning water content is greater); (2) the section curve followed is steeper; and (3) the difference in water content between the first and last plates is greater after a definite heating period. A determination of the portion of grains under 4μ in diameter was made by sedimentation. This showed that the more plastic materials contained a greater amount of fine particles. E.J.V.

Analysis of factors contributing to the determination of saturation capacity in some tropical soil types. P. E. TURNER. *Jour. Agric. Sci.*, **22** [1], 72–91 (1932).—Fifty-six soil specimens were investigated. Data are presented which show that saturation capacity is closely related to the content of clay and organic matter of soil but not to the fine silt fraction. A close prediction of the saturation capacity may be made from an expression of the form, saturation capacity $= \alpha + \beta x_1 + \lambda x_2$, where α, β, and λ are constants depending on the soil type and x_1 and x_2 are the contents of organic matter and clay, respectively. The capacity for base exchange of the inorganic components of the soil decreases rapidly when the particles attain a diameter of 0.002 mm. When the ratio of clay to organic matter exceeds 20, the organic matter may be present almost entirely in the form of surface films on the inorganic particles. J.L.G.

Measurement of the electrical conductivity of aqueous soil suspension and its use in soil fertility studies. ASHUTOSH SEN. *Jour. Agric. Sci.*, **22** [1], 212–34 (1932).—A rapid method of measuring the conductivity of soil suspensions was developed and conclusions were drawn concerning the variation of conductivity with fertility in the case of several soils examined. J.L.G.

Improved sedimentation method for the determination of particle sizes, using an automatic recorder. C. G. SUMNER. *Trans. Faraday Soc.*, **28** [1], 20–27 (1932).—An improved technique, developed from the method of Lambert and Wightman, for applying an automatic recording camera to the determination of particle sizes by a sedimentation tube method is described. G.R.S.

Determination of particle size of surface soil, loam, and clay. P. JAKUSCHOFF. *Tonind.-Ztg.*, **56** [12], 168–71 (1932).—Different methods for a continuous determination of the particle size are described. Either the sedimentation is carried on while a belt is moving continuously within the liquid under the vessel containing the sample, or the velocity of the particles moving in a glass tube is determined by means of a stopwatch. With a third method, the sample to be tested is placed in front of a photoelectric cell and the change is determined in the electron emission of the cell as a function of the amount of solid particles. Illustrated. W.M.C.

Measuring the smallest particles in ceramics. RUDOLF LORENZ. *Sprechsaal*, **65** [4], 59–61; [5], 80–82 (1932).—L. points out the importance of exact measurements of the finest particles in ceramics and discusses the following different methods used: (1)

the elutriation analysis according to Schöne and Schultze-Harkort, (2) the sedimentation analysis according to Wiegner-Gessner, and (3) the pipette method according to Krause, Robinson, and Andreasen. The equations of Schöne and Stokes are explained and their usability discussed. L. improved the apparatus used in the pipette method of Andreasen and explains its use. This sedimentation apparatus may be used for flocculation measurements also. M.V.K.

Kelly tube and the sedimentation of Portland cement. C. G. DUNCOMBE AND J. R. WITHROW. *Jour. Phys. Chem.*, **36** [1], 31–51 (1932).—A formula is proposed which is believed to be more accurate than that used by Kelly. The modified Wiegner apparatus developed by the authors entirely eliminates evaporation loss, has almost no lag, and permits the use of viscous liquids in the side tube. The measuring error of the apparatus is less than 0.1% of the total range covered. G.R.S.

Rapid method of microscopical determination of quartz. P. P. BELIANKIN AND ONISSIMO-YANOVSKI. *Ceramics & Glass*, **7** [11–12], 41–42 (1931).—The authors describe the microscopic determination of the quartz content of an artificial mixture consisting of 30% quartz and 70% microcline (the mixture is similar to pegmatite from Mourmansk) according to the method of Insley (see *Ceram. Abs.*, **6** [10], 468 (1927)). The results were satisfactory. M.V.K.

Principles of microchemical methods. ANON. *Chem. Trade Jour.*, **90** [2333], 122–24 (1932).—The following points are discussed: (1) some representative uses, (2) methods for qualitative work, (3) detection of chlorine and sulphur, (4) micromethods for quantitative working, (5) the filter stick and its use, and (6) volumetric and nephelometric methods. M.V.K.

Psychrometric table for relative humidity. ANON. *Proc. A.S.T.M.*, **31** [Part I], 567–72 (1931).—A psychrometric relative humidity table which combines both accuracy and convenience to an exceptional degree is described. R.A.H.

BOOKS AND BULLETINS

Potentiometric Titrations. I. M. KOLTHOFF AND N. HOWELL FURMAN. 2d ed. 482 pp. John Wiley & Sons, New York. Price $6.00. *Can. Chem. Met.*, **16** [2], 46 (1932).—This new edition contains many changes and extensions. Part I deals with the theory and fundamental principles; Part II gives an extensive discussion of recent additions to the technique of potentiometric titrations; Part III gives a complete account of existing methods; Part IV is an attempt to cover the complete literature on the practical application of potentiometric titrations to various problems. An extensive bibliography and reference tables of physicochemical data complete the volume. E.J.V.

Matter and Atoms. (Matière et atomes.) 2d ed. A. BERTHOUD. Gaston Doin et Cie., Paris. 324 pp. Price 26 F. *Can. Chem. Met.*, **16** [2], 46 (1932).—This edition brings the subject matter up to date. The relativity theory is treated comprehensively and transformation equations are worked out in an elementary way. Atomic numbers, isotopes, the Rutherford and the Bohr atoms, and the theory of quanta are well summarized, and a good account is given of the modern wave mechanics. E.J.V.

Spectroscopy of X-Rays. (Spektroskopie der Röntgenstrahlen.) MANNE SIEGBAHN. Published by Julius Springer, 1931. vi + 573 pp. Reviewed in *Jour. Phys. Chem.*, **36** [2], 765–66 (1932).—The book is a standard work on X-ray spectra. The chapters are (1) knowledge before Laue's discovery of diffraction, (2) X-ray optics, (3) technique, (4) emission spectra, (5) adsorption spectra, (6) theory of X-ray spectra, (7) investigation of the long-wave region, and (8) the continuous spectrum. G.R.S.

Colloids. ERNEST S. HEDGES. Published by Edward Arnold and Co., 1931. vii + 272 pp. Reviewed in *Trans. Faraday Soc.*, **28** [2], 128 (1932).—The book, written

especially for students of chemistry, has been treated in a sufficiently broad way to interest students of physics, biology, and geology. G.R.S.

Colloidal Chemistry in Ceramics. (Kolloid Chemie in der Keramik.) HANS KOHL. *Ceram. Ind.*, **18** [2], 142 (1932); *Refrac. Jour.*, **7** [12], 514 (1931); for review see *Ceram. Abs.*, **10** [12], 870 (1931). W.W.M.

Industrial Chemical Calculations; the Application of Physico-Chemical Principles and Data to Problems of Industry. O. A. HOUGEN AND K. M. WATSON. John Wiley & Sons, New York. 502 pp., diagrams, charts, and tables. Price $4.50. *Gas Age-Rec.*, **69** [9], 258 (1932). E.J.V.

Plasticity. A. NADAI. Translated by A. M. WAHL. Reviewed in *Chem. Met. Eng.*, **38** [11], 667 (1931); for review see *Ceram. Abs.*, **11** [2], 139 (1932). G.R.S.

Bibliography of Bibliographies on Chemistry and Chemical Technology. CLARENCE J. WEST AND D. D. BEROLZHEIMER. *Bull. Nat. Research Council*, No. 86, 150 pp. (1932). J.L.G.

Application of X-Ray Crystal Analyses to Industrial Problems. DEPT. OF SCIENTIFIC AND INDUSTRIAL RESEARCH. Published by H. M. Stationery Office, London. Price 9d, net. Reviewed in *Metal Ind.* [London], **39** [11], 242 (1931).—The book comprises a report on the application of X-ray methods to industrial research and the results so far attained. Reference is made to the differentiation in metallic alloy systems between mixtures, solid solutions, and compounds, to the estimation of crystal size, and to the orientation produced by mechanical working or electrolytic depositions. X-ray analysis has also shown that many substances usually considered to be amorphous are in reality crystalline. M.V.K.

Report of the Committee on Hydrodynamics. HUGH L. DRYDEN, FRANCIS D. MURNAGHAN, AND H. BATEMAN. *Bull. Nat. Research Council*, No. 84, 600 pp. (1932).—The theory and mathematics of hydrodynamics are presented. The report is divided into four parts: (1) the physics of fluids and classical hydrodynamics, (2) motion of an incompressible viscous liquid, (3) turbulent flow, and (4) compressible fluids. J.L.G.

Book Review

A Manual for Preparing Piezo-Quartz Preparations. A. V. SHUBNIKOV, M. N. ABAZA, V. Z. BULVANKER, L. S. GENERALOVA, G. G. LEMMLYN, S. A. TIESENGANSEN, AND E. V. CINSERLING. The Publishing House of the Academy of Sciences of U.S.S.R., Leningrad, 1931. 55 pp. 57 figs. Price 1R. This manual is a collective work compiled by the workers of the Quartz Laboratory of the Mineralogical Institute at the Academy of Sciences of U.S.S.R. It is the result of a five-year research work on quartz, undertaken because of numerous requirements of piezo preparations from research institutes and industrial establishments. The book deals with (1) crystallography and physics of quartz: (*a*) modifications of quartz, (*b*) geometrical shape of quartz crystals, (*c*) optical axis and the electrical and mechanical axis, (*d*) birefringency and the rotation of the plane of polarization, (*e*) dextro and levo quartz, (*f*) twins, (*g*) piezo-electric effect, (*h*) cleavage, (*i*) the oscillation of quartz plates in the alternating electrical field, (*j*) the wave-length and wave coefficient, (*k*) excitation of oscillations in a quartz plate, and (*l*) the quartz plate as a stabilator of the frequency; (2) the equipment of the laboratory: (*a*) polarizing microscope and polarizing apparatus, (*b*) quartz grinding devices, etc., (*c*) twenty-four objects necessary to work with quartz, (*d*) twenty-six objects necessary to prepare piezo-quartz plates; (3) preparative works: (*a*) preparing diamond powder, (*b*) preparing a disk for the diamond saw from sheet iron, (*c*) grading and elutriation of silicon carbide, (*d*) preparing green crocus (Cr_2O_3), (*e*) preparing paraffin vessels; (4) preparing monocrystal material; (5) preparing right-angled plates; (6)

preparing circular plates; (7) preparing Marrison's rings; (8) mosaics; four methods for their preparation; (9) testing the plates; (10) grinding the plates for a given wavelength; (11) quartz balls as piezo preparations; (12) grinding thin plates (0.3 mm.). The book is well printed and has a large number of well chosen and reproduced illustrations. It contains useful scientific and practical data and those interested in the preparation of piezo-quartz preparations will find the manual of great value.

SELICK I. PERKAL

PATENTS

Detergent. KARL DAIMLER. U. S. 1,843,316, Feb. 2, 1932.

Making magnesium titanate. SIMON J. LUBOWSKY. U. S. 1,843,427, Feb. 2, 1932.

Treatment of titanium and iron-containing materials. BYRAMJI D. SAKLATWALLA. U. S. 1,845,342, Feb. 16, 1932.

Purification of impure dioxide of titanium containing, in particular, chromium. NORBERT SPECHT. U. S. 1,845,633, Feb. 16, 1932.

Producing white lead. GUNNARD E. JOHNSON, REGINALD G. BOWMAN, AND WILLIAM J. KNOX, JR. U. S. 1,845,713, Feb. 16, 1932.

Production of titanium pigments. CHARLES DE ROHDEN. U. S. 1,846,188, Feb. 23, 1932.

Manufacturing a red pigment of iron oxide. ERICH RENKWITZ. U. S. 1,848,660, March 8, 1932.

Titanium pigments. TITANIUM PIGMENT CO., INC. Brit. 364,562, Jan. 20, 1932.

Preparation of titanium compounds. W. B. LLEWELLYN, H. SPENCE, AND P. SPENCE & SONS, LTD. Brit. 364,613, Jan. 20, 1932.

Tin oxide gels. SILICA GEL CORP. Brit. 364,663, Jan. 20, 1932.

Working up cryolite. L. MELLERSH-JACKSON. Brit. 364,890, Jan. 20, 1932.

Electrically inspecting bodies to detect hidden or other flaws therein. SPERRY DEVELOPMENT CO. Brit. 365,555, Feb. 3, 1932.

Removal of colloidal silica from mixed solutions obtained during the treatment of powdered silicates with acids. G. A. BLANC. Brit. 366,002, Feb. 10, 1932.

Treatment of materials containing silica. E. J. KOHLMEYER. Brit. 366,015, Feb. 10, 1932.

General

Circulation of water in clay masses during their drying. F. A. ZENKOVICH. *Ceramics & Glass*, **7** [11–12], 46–50 (1931).—Z. describes the results of investigations on the circulation and distribution of moisture in a clay mass during drying of different kinds of clays, kaolin, and porcelain masses. Special hollow brass cylinders were filled with the masses; one end of each cylinder was insulated from any access of atmospheric air, while the other end remained open. At definite intervals, the masses were examined for their moisture content. The volume and water content were determined. M.V.K.

Dependence of the shrinkage of ceramic masses on mechanical influences. D. A. SHMELEV. *Ceramics & Glass*, **7** [11–12], 50–53 (1931).—Experimental data on the shrinkage of ceramic masses which are subjected to mechanical influences during the manufacturing of ware are given. It was found that a mechanical action exercised upon the clay during its working produces two kinds of shrinkage: one, the larger, acts in the direction of the mechanical power applied, while the second, which is smaller, is found in a plane perpendicular to this direction. M.V.K.

Fundamental principles of water treatment from the chemical engineering standpoint. W. W. HODGE. West Va. Univ. Eng. Expt. Sta., *Bull.* No. 4, **16** [6], 20–31 (1931). E.C.C.

The A B C of water purification. L. V. CARPENTER. West Va. Univ. Eng. Expt. Sta., *Bull.* No. 4, **16** [6], 11–19 (1931). E.C.C.

Technical operation in kaolin works. M. POHORZELECK. *Z. Ver. deut. Ing.*, **75** [41], 1275–79 (1931); *Feuerfest*, **8** [1], 12 (1932).—P. describes the methods used for preparing kaolin in several kaolin works. See also *Ceram. Abs.*, **11** [2], 141 (1932). M.V.K.

Economics of the nonmetallic mineral industries. XIII. Large *vs.* small companies. RAYMOND B. LADOO. *Rock Prod.*, **35** [5], 48–49 (1932).—L. discusses the trend toward large companies and some of the differences between large and small corporations. If properly managed, the large concern has advantages over the small one. For Part XII see *Ceram. Abs.*, **11** [4], 283 (1932). W.W.M.

Report of the Department of Scientific and Industrial Research for the year 1929–1930. ANON. *Mech. World*, **89** [2308], 293 (1931); for abstract see *Ceram. Abs.*, **10** [12], 844 (1931); see also following abstract. E.P.R.

Department of Scientific and Industrial Research Report for the year 1930–31. ANON. *Refrac. Jour.*, **8** [2], 72 (1932).—This report contains a summary of the year's work of the various research boards, with notes of the important technical papers and reports issued by the Boards during 1931. The report covers all branches of industrial research work and particular attention is devoted to fuel, building and steel structures, metallurgy, and lubrication. E.P.R.

Kaiser Wilhelm Institute for silicate research. ANON. *Tonind.-Ztg.*, **55** [102], 1418–21 (1931).—At a meeting of the Society "Friends of the Kaiser Wilhelm Institute for Silicate Research," papers on the following subjects were presented: (1) attack of silicate melts on refractories, by Salmang (see *Ceram. Abs.*, **11** [3], 179 (1932)), (2) ceramic ware made of pure magnesia, by Bichowsky (see *ibid.*, **11** [4], 247 (1932)), (3) measurement of stress by means of a bending test, by Steger, (4) a new method to determine the reactions taking place during the setting of cement, by Guttmann (see *ibid.*, **10** [2], 99; [3], 172 (1931)); (5) properties of tricalcium silicate, by Haegermann, (6) reactions between water and cement, by Kühl (see *ibid.*, **11** [3], 156 (1932)), and (7) specific heats of the components of clinkers and investigations of a rotary kiln, by Schwiete. W.M.C.

How maintenance was organized for incentive payment. ALFRED VAKSDAL AND FREDERICK S. KRIGER. *Maintenance Eng.*, **90** [3], 98–109 (1932).—A method is outlined which organizes maintenance functions and duties in all their details by means of charts. Each function and duty is specifically assigned to the man best fitted for it. A cost system records the expenditures and fixes the responsibility for them. Nine pages of charts are included. J.L.G.

Plant engineering in the automotive industry. G. A. HOLMES. *Maintenance Eng.*, **90** [3], 116–17 (1932).—The scope of maintenance work in an automobile plant is outlined. J.L.G.

Making depression profits through management. HERSCHEL B. DAVIS. *Brick Clay Rec.*, **80** [1], 19–21 (1932).—D. discusses the success of the Des Moines Clay Co. in showing a profit through an adherence to a strict budget and a determination to keep inventories down. E.J.V.

General Edward Orton, Jr. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **11** [3], 43–55 (1932).—A brief biographical sketch and eulogy of the founder of the SOCIETY are presented. E.J.V.

Impressions of the American pottery industry. JOHN THOMAS. *Pottery Gaz.*, **57**

[656], 237–39 (1932).—T. deals with the following points as observed in a 12-week tour of America: America as a potential market for greater exploitation by British pottery manufacturers; the mass production of pottery in the U. S. as contrasted with some British methods; tariffs in America as affecting producer and consumer; the value of publicity campaigns, exhibitions, etc. The lack of skyscraper potteries, small size of most of the potteries, use of cheap fuel, types of managers encountered, quality of the ware, and marketing methods are discussed. E.J.V.

Annual exhibition of physical and optical societies. ANON. *Chem. Age*, **24** [602], 25 (1931). C.G.H.

British chemical plant exhibition. ANON. *Chem. Trade Jour.*, **89** [2303], 27–35 (1931).—Among different products exhibited were (1) objects coated with alkali-resisting enamel free from lead, (2) stoneware centrifugal pumps, and (3) a range of stoneware for storing and handling corrosive liquids and gases. M.V.K.

Autumn meeting of the Refractory Materials Section of the Ceramic Society. ANON. *Refrac. Jour.*, **7** [12], 527–38 (1931).—The 24th meeting of the Refractory Materials Section of the Ceramic Society was held at the rooms of the Chemical Society, Nov. 18 to 20, 1931, under the chairmanship of W. J. Gardner. E.P.R.

BOOKS

Principles of Patent Law for Chemical and Metallurgical Industries. ANTHONY W. DELLER. Chemical Catalog Co., New York. 483 pp. Price $6.00. Reviewed in *Blast Fur. Steel Plant*, **20** [2], 199 (1932); *Can. Chem. Met.*, **16** [1], 46 (1932). E.J.V.

The Degradation of Science. T. S. HARDING. xiii + 386 pp. Farrar & Rinehart, 1931. Price $3.00. Reviewed in *Sci. Monthly*, **33**, cover page (Nov., 1931).—H.'s thesis is that science has been "shamelessly abused and unscrupulously exploited." H.H.S.

PATENT

Manufacture of clay. WILLIAM FELDENHEIMER. U. S. 1,847,212 March 1, 1932.

LUSTERLITE ENAMELS

THERE is satisfaction in knowing that the frit you purchase is of the finest quality and that the service is dependable.

There is greater satisfaction in knowing that the frit is *uniformly* fine and that the service is *consistently* dependable.

When you buy Lusterlite Frit you buy *product finish insurance.*

Chicago Vitreous Enamel Product Co.

CICERO ILLINOIS

PQ

SILICATE OF SODA

"N" Brand

For deflocculating clays and increasing plasticity.

Available from 8 plants and 66 distributing points.

Samples and further information on request.

PHILADELPHIA QUARTZ COMPANY

General Offices
121 S. Third St., Philadelphia
Chicago Office: 205 W. Wacker Drive

$11,643.00 Saved in Drying

By replacing an old method with a new and efficient drying system. Two Ruggles-Coles indirect heat dryers were installed in a clay plant to dry at the rate of 11 tons per hour. Former drying costs 52¢ per ton—present costs 36¢ per ton—a saving of $11,643 per year.

Hardinge Company, Inc., York, Pa.

122 East 42nd St. New York
205 W. Wacker Drive Chicago, Ill.
235 Montgomery St. San Francisco, Calif.

This is no time for "Buying by Habit"

Today Ceramic manufacturers must test things by themselves—make sure that every penny they spend for materials brings them the largest possible return. Buying by habit has no place in the aggressively-alert plant today.

One of the most important materials to receive severe tests by the ceramic industry was OPAX—the ultimate opacifier. This is unquestionably the reason for the astounding success of OPAX—its dominant use by leaders in every branch of the industry today. They are convinced of OPAX'S superiority. They have thrown overboard the traditions of yesterday.

OPAX is a zirconium oxide. Makes enamels brilliantly whiter, more opaque, tougher and glossier. It is inert, irreducible, non-poisonous and always uniform in quality. Does not contain antimony, lead or tin.

OPAX is a TAM product of research. A domestic product—always uniform and available. Write for a sample keg today.

The Titanium Alloy Mfg. Co.

Ceramic Materials Division

1202 Keith Bldg. Cleveland, Ohio

BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

Walter P. Suter Kenneth E. Smith	Art	S. M. Phelps H. E. White	Refractories	Amos P. Potts Marion W. Blair	Structural Clay Products
W. V. Knowles W. N. Harrison	Enamel	H. M. Kraner Louis Navias	White Wares	H. F. Kleinfeldt	Materials and
E. Ward Tillotson Jack H. Waggoner	Glass	R. F. Grady, Jr. Donald J. Watson	Terra Cotta	V. V. Kelsey	Equipment

OFFICERS OF THE SOCIETY

Emerson P. Poste, President
Box 51, North Chattanooga, Tenn.
W. Keith McAfee, Vice-President
Universal Sanitary Mfg. Co., New Castle, Pa.
H. B. Henderson, Treasurer
1445 Summit St., Columbus, Ohio
Ross C. Purdy, General Secretary and Editor
Emily C. Van Schoick, Assistant Editor
2525 N. High St., Columbus, Ohio

TRUSTEES

E. V. Ebersen
Alexander Silverman
C. L. Sebring
W. C. Lindemann
F. C. Flint
V. V. Kelsey
J. M. McKinley
H. C. Kleymeyer
D. F. Albery
D. P. Forst

Vol. 11 May, 1932 No. 5

EDITORIALS

PREPARE FOR CRITICAL MARKETS

To get ahead, the ceramic technologist and engineer must be eternally engaged in finding new uses for his products and new adaptations of his product materials. He must know how to work his materials into products that will meet definite quality specifications. He must know the conditions of use and the limitations of his product. He must know what quality standards to maintain and how to control their maintenance.

Product and product uses should be major items in each ceramic school curriculum; these should be the end purposes for acquiring knowledge and facility in the use of chemical, physical, and mathematical laws and concepts.

It was the translation of product requirements into terms of materials, processes, and products that prompted the production of artificial abrasives in electric furnaces, the production of cast mullite refractories, and many other products. The creation of special superior refractories was made by others than those engaged in the so-called standard refractory ware

lines. These refractories have been profitable, holding up well even through business depression.

It is by analyzing conditions and specifications to be met and by adapting materials and processes to the making of products to meet these conditions and specifications that producers of nonceramic products have made serious inroads in the lines which heretofore had been exclusively satisfied by ceramic products. This is true in grinding wheels, food containers, tableware, electrical insulators, and other ware.

Conversely, inattention and a lack of an exploring habit of mind have caused ceramic ware makers to lose business to competitive products. There is a woeful lack of service data and a woeful indifference as to whether the product sold will give creditable service under the conditions of use. There have been so much defective china, improperly fired brick and terra cotta, poor quality sewer pipe, unsuitable glassware, and inefficient ceramic-bonded grinding wheels, and so little study given to the service conditions and demands that it has been easy for producers of nonceramic products to gain a large portion of what were once ceramic fields exclusively.

It is to be hoped that the ceramic schools will give emphasis to product qualities and service demands. May it never again be possible for a noted university professor to confess that as far as he knew "structural tile ceased to be a masonry unit twenty years ago."

A NEW USE FOR ENAMELWARE

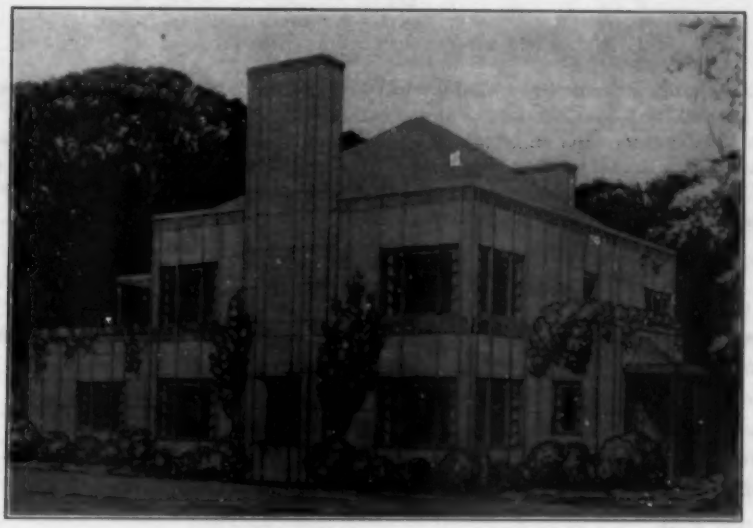
The Ferro Enamel Corporation is building a porcelain enamel faced metal residence. Wm. Dubar Company is the contractor and Charles Bacon Rowley and Associates are the architects. The location will be on Campus Drive near Notre Dame College, Cleveland, Ohio.

This house will have exterior walls of a color resembling rich buff limestone with a band of silver green under the parapet and forming a belt course above the first story. The porcelain enameled roof shingles will be in three shades of russet or rust color. A dull or "mat" finish enamel will be used. Rustless steel will be employed in the entrance details and in windows and doors.

Here is a new challenge by a ceramic product which formerly was not considered a structural material. Already enameled wall tile has found a market. As early as 1928 the White Castle System of Eating Houses Corporation constructed its buildings of enameled steel. Enameled iron is bidding for structural business and will get a large share of it.

The enterprise of the Ferro Enamel Corporation in conceiving and constructing this enameled steel house will continue on to the discovery of

many more uses for enameled steel. Its service engineers are ever searching for new uses for enameled steel and iron. They make exhaustive studies of the conditions to be met. They employ their research resources



in finding the form of product, the character of enamel, and the process of enameling that will result in the product needed.

Enamelware manufacturers will find ever-expanding markets in proportion to their employment of intelligent, aggressive search for new uses and in proportion to the research work done on the adaptation of their product exactly to meet new service requirements.

PAPERS AND DISCUSSIONS

A LABORATORY TEST FOR THE HARDNESS OF SANDBLAST SAND*

By Emerson P. Poste

ABSTRACT

The change in fineness of a sand produced by grinding a 200-gram sample in a standard jar mill for 1 hour is taken as an indication of its durability in sandblasting. Results of laboratory tests on certain sands are compared with the change in fineness of these sands in actual sandblasting operation. The test is applied to sands known to be of inferior quality. Discussion of the results is based on the assumption that sand finer than 40-mesh has but little sandblasting value.

I. Introduction

In settling a dispute between buyer and seller, it became necessary to establish the relative merit of two cars of sandblast sand. Only a small sample of an earlier shipment, admittedly satisfactory, was available; not enough to serve as a standard of comparison on a commercial scale. The desirability of a laboratory test became evident.

It was reasoned that the property of a sand by virtue of which it resists breakdown in use would offer resistance to disintegration by impact in a pebble mill.

II. Method

For use as a test mill, a standard porcelain jar 4 inches in diameter by $3^3/_4$ inches deep was chosen, carrying a charge of 600 grams of porcelain pebbles ranging from $^3/_4$ to $1^1/_4$ inches in diameter. A sample of 200 grams of dry sand was ground for one hour at a mill speed of 60 r.p.m. The fineness figures for a given sand before and after grinding were compared to give an indication of the ability of the sand to resist breakdown by impact. To facilitate the interpretation of data the cumulative figures were plotted.

III. Laboratory Tests

Test 1 As a standard with which to compare other sands a run was made on the sample of sand from the previous lot which was recognized as satisfactory.

Mesh	Before (%)	After (%)
On 20	1.1	1.0
40	97.7	81.4
60	99.9	92.6
80	99.9+	93.8
100	99.9+	95.4
150	100.0−	96.3
Pan	100.0	100.0

* Presented at the Annual Meeting, American Ceramic Society, Washington, D. C., February, 1932 (Enamel Division).

Test 2 A sample from the car claimed to be inferior gave the following results:

Mesh	Before (%)	After (%)
On 20	2.2	1.5
40	96.6	81.0
60	99.1	92.1
80	99.3	93.2
100	99.4	94.8
150	100.0−	95.7
Pan	100.0	100.0

Test 3 In like manner a sample from the second car, admittedly of good quality, ran as follows:

Mesh	Before (%)	After (%)
On 20	1.1	1.0
40	98.3	80.6
60	99.8	91.2
80	99.8+	93.0
100	99.9	94.9
150	99.9+	95.7
Pan	100.0	100.0

The data from these tests are plotted on Fig. 1. The upper curves indicate the original fineness of the sand, the lower ones the fineness after grinding.

The quality of the three samples is indicated to be essentially the same; in fact the three sets of curves would constitute a good check for triplicate runs on the same sand.

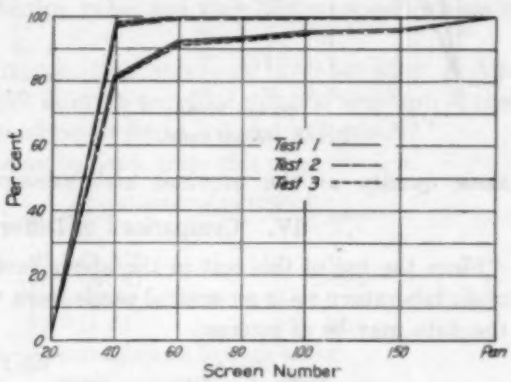


FIG. 1.—Laboratory tests.

III. Shop Tests

In an effort to correlate these experimental data with shop performance two test runs were made in a sandblast house, blasting like amounts of similar stove castings with essentially equal weights of the sands represented above by Tests 2 and 3. In each case the blast system was clean at the start, making possible accurate weighing of sand. Test 4 involved sand used in Test 2; Test 5, that used in Test 3.

	Test 4 (lb.)	Test 5 (lb.)
Original weight sand	1092	1080
Recovered weight sand	859	850
Lost as dust	233	230

Fineness tests were made on the recovered sand. It was assumed that the lost dust would have passed a No. 150 screen and the fineness data for the recovered sand were figured back to the original weight, the dust lost being computed to the "pan." These calculations are shown below.

Mesh	Test 4 Before (%)	Test 4 After (%)	Test 5 Before (%)	Test 5 After (%)
On 20	2.0	0.9	1.1	0.3
40	95.7	40.0	97.3	45.5
60	99.5	69.5	99.1	72.5
80	99.6	74.5	99.9	75.0
100	99.9	79.0	99.9+	77.5
150	100.0	79.5	100.0	78.5
Pan	100.0	100.0	100.0	100.0

These data, plotted as in the laboratory tests, are shown as Fig. 2 with the average of the laboratory test curves included for reference.

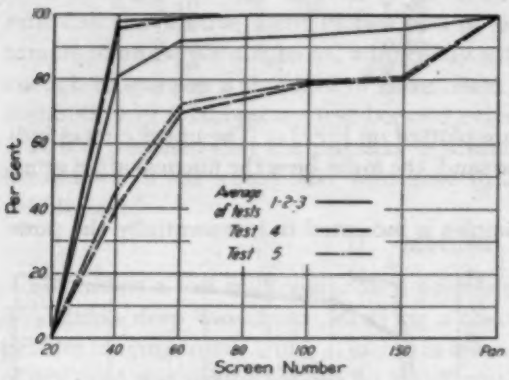


FIG. 2.—Shop tests.

Although the curves for the two lots of sand after use do not exactly check, they are not materially unlike and were taken to indicate a reasonable uniformity of quality for the two sands involved.

These data from laboratory and shop tests were sufficient to convince the buyer that the car of sand in doubt was of practically the same quality as the previous and subsequent lots.

IV. Comparison of Different Sands

Since the use of this test in the above case, there has been occasion to make laboratory tests on several sands from various sources and certain of the data may be of interest.

Mesh	Test 6 Before (%)	Test 6 After (%)	Test 7 Before (%)	Test 7 After (%)	Test 8 Before (%)	Test 8 After (%)
On 20	58.4	28.9	97.4	49.3	1.8	0.2
40	97.1	70.3	99.9	69.0	99.9	58.7
60	99.3	84.1	99.9	79.8	99.9	82.4
80	99.5	86.3	100.0	82.2	99.9	85.3
100	99.7	89.4	100.0	86.1	99.9	89.8
150	99.9	92.7	100.0	88.0	99.9	92.6
Pan	100.0	100.0	100.0	100.0	100.0	100.0

These figures are plotted as Fig. 3, which shows for comparison the results of Test 1.

These curves bring out pertinent facts as to the sands involved. Test 6 shows a sand of intermediate initial fineness which breaks down quite rapidly. Test 7 covers a coarse sand which also shows a rapid disintegration. The sand in Test 8 is of particular interest because its original fineness is practically the same as that of Test 1 while the reduction of size in the jar is far more pronounced than that for the sand in Test 1. This would be taken as a definite indication of inferior quality.

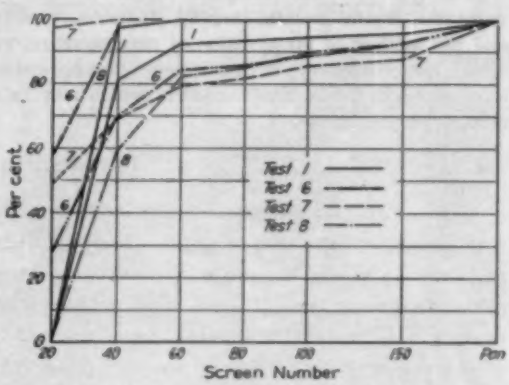


FIG. 3.—Comparison of different sands.

V. Discussion

This scheme has had no extensive use and is not claimed to be a proved method. It has been favorably commented on by men who are familiar with sandblasting and who feel the need of some laboratory method of evaluating sands.

A point which is open to difference of opinion is the proper fineness of sand for best results. Some persons feel that sand fine enough to pass a 40-mesh screen is of little blasting value and they buy on specifications in line with that idea.

If it is assumed, for discussion, that only sand over 40-mesh in size is effective, should very coarse sand be purchased on the assumption that it would stand more punishment before being reduced to 40-mesh?

A comparison of the data may be made from this point of view.

Test No.	Amount Retained on 40-Mesh Before (%)	After (%)
1	97.7 (1.1)*	81.4
6	97.1 (58.4)	70.3
7	99.9 (97.4)	69.0
8	99.0 (1.8)	58.7

* The figures in ( ) are the amounts retained on 20-mesh screen.

The relatively coarse sands represented in Tests 6 and 7 show a greater breakdown on a 40-mesh basis than did the finer sand of Test 1. On the other hand the sand in Test 8, similar to that in Test 1 as to initial fineness, broke down to the poorest figure of all on the 40-mesh standard.

Apparently the inherent ability of the sand to withstand impact is at least an important consideration.

P. O. BOX 51
NORTH CHATTANOOGA STATION
CHATTANOOGA, TENN.

THE MOTION PICTURE AS AN AID TO REFRACTORIES RESEARCH[1]

By Thomas S. Curtis

ABSTRACT

The apparatus and technique employed in the study of plastic flow at high temperatures, crystal growth, thermal expansion, vitrification, spalling, etc., are described, and the method of preservation of permanent records of such phenomena in the act of occurrence is given. A description is also presented of the physical changes requiring days or weeks for their development which may be depicted in a few minutes on the motion picture screen.

I. Introduction

A motion picture film entitled "Evolution of Mullite Refractories" was presented at the Toronto meeting of the American Ceramic Society in 1930. The film presented a condensed record of several years of investigation covering the physical relationship of the amorphous and crystalline phases of refractory bodies. The elementary principles of the relationship were presented by means of simple analogy and culminated in the demonstration of crystal growth, the control of plastic flow at high temperature, and the attainment of stable volume in commercially-manufactured refractory materials.

Since that time many requests have been received for a written paper on the subject, but it has been found impossible to do justice to the film in view of the futility of an attempt to reduce to inanimate photographs and printed words what the living motion picture reveals. The present paper, however, does present a description of the technique and apparatus employed in the production of the film.

II. Technique of Manipulation

The idea which finally crystallized in the film was gained years ago with the viewing of a motion picture of a flower slowly opening. Motion that was so slow as to be imperceptible to the eye became clearly observable and understandable when reduced to a few minutes on the screen.

The first reduction to practice of the idea occurred several years ago when an accelerated motion picture was made of a bar of particularly treacherous clay during the act of shrinkage. Alongside the clay was a common alarm clock and a thermometer to form a record of time and temperature as the clay passed through the various stages of shrinkage and warpage. The information gained from a one-hundred foot strip of film, photographed over twenty-four hours of time, enabled a particularly troublesome drying problem to be solved in less than a week, although this

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division).

same problem had been fought for three months prior to the advent of the living record of what happened.

The next attempt was the recording of the expansion of two refractory brick placed side by side in the same furnace. While the usual recording graph illustrates this same thing, the relative suddenness of expansion in a silica brick was much more graphically illustrated in the film record.

There followed a successful accelerated motion picture of the plastic flow of three brick stood on end. All three had approximately the same composition but were of different physical structure. From this last strip came the idea of studying the relation of crystal and glass concentrations in refractories.

FIG. 1.—Bausch and Lomb motion photomicrographic equipment showing change gear device to enable pictures to be taken at speeds of from 16 per second to one picture every four minutes.

With the gradual development of a technique came more ambitious plans. It was reasoned that if the shrinkage and vitrification of clay could be observed and recorded, it would be but a step to the observation of what happened to the individual particles of that clay as the temperature increased. Accordingly, some inquiries were made as to available thermal stages for the microscope.

After nearly a year's search both abroad and in this country, it was apparent that available equipment was not suitable nor could it be adapted. Since it was desired not only to observe but also to record, the first requisite was a stage upon which the specimen could be laid and upon which it could move about, at the same time being kept approximately in the focal plane of the lens.

The result was the designing and building of simple, perhaps crude, but

withal quite useful makeshifts which served their purpose sufficiently well to permit the production of what is believed to be the first living record of silicate fusions ever placed upon motion picture film.

III. Types of Apparatus Required

The budget required for the apparatus may be expressed in three or more figures. If infinite precision is demanded, the cost may reach thousands of dollars. If something short of near-perfection will answer, a few hundred dollars will make a good start.

FIG. 2.—Binocular microscope set up with thermal stage and 35-mm. motion picture camera. Ground-glass viewing screen at right of camera with rheostat for control of temperature in right foreground.

Since the earlier work in the Vitrefrax Laboratories was done, an American manufacturer of optical equipment has introduced a beautifully designed and executed apparatus which could not better have been made to order both for macroscopic and microscopic work. This apparatus is moderately priced and is adapted for use with the amateur standard or 16-mm. film which is much less costly than standard 35-mm. stock. This apparatus is probably the ideal for the average laboratory unless precision in reproduction is paramount. In the latter case, if the appropriation permits, the best records are made upon 35-mm. film in one of the regular professional cameras equipped with change gear device and electric motor drive.

Recourse may also be had to one of the amateur cameras of either 35-mm. or 16-mm. size equipped with hand crank and at least four speeds, that is, one, two, four, or eight pictures per revolution of the crank. Such cameras may be had for less than one hundred dollars.

For motion photomicrographs, no camera lens is required, the optical system of the microscope affording the necessary lenses. For direct motion pictures of gross objects, one good lens of F/3.5 speed or more is needed, and for the photography of objects inside furnaces a telephoto lens will be necessary. This latter enables large images of relatively small objects to be photographed through a small aperture in the furnace wall without bringing the lens so near the opening as to damage the equipment from heat.

FIG. 3.—Thermal stage shown at full heat and without protective sheath illustrating method of illumination with arc lamp.

For the photography of melts of ceramic material to show the relative activity of various fluxes and the influence of particle size, the most convenient set-up is afforded by one of the modern binocular, stereoscopic microscopes. One leg of the instrument projects its image into the motion picture camera, while the other projects the image upon a ground glass in a suitable hood so that continuous observation of the field is possible while running the film. There are many standard binocular instruments on the market, but the author's choice is one in which the objectives may be focused independently to bring both fields in focus at the same plane on the respective ground glasses. This convenience will be appreciated when the instrument is used for motion photography as above described.

The thermal stage upon which the specimens are placed is simple. It consists of a strip of pure platinum foil approximately one-quarter inch wide by one inch long, held at either end by brass clamps which in turn are supported by spring brass strips, the whole so disposed as to permit the platinum to expand longitudinally without moving out of the plane of focus of the lens. The current for heating the strip is supplied by a small 6-volt transformer such as is used in connection with ribbon-filament

microscope lamps. A rheostat wound with approximately No. 12 wire is placed in series with platinum and transformers to enable temperature to be controlled.

The stage as above described is clamped to the base of the microscope with the center of the platinum in line with the focal axis of the objective lenses. Over the platinum is placed a sheath of any pure refractory material, magnesium oxide being used in this set-up. This sheath rests upon the brass clamps and through an opening in the top may be seen the object on the platinum stage, while the beam of light from the arc lamp is projected obliquely upon the object through an open end of the sheath.

FIG. 4.—Close-up of simple type of thermal stage showing strip of platinum at the focal point of the binocular lens. Sheath removed.

Thus most of the radiant heat is kept within the little refractory sheath and for all but prolonged exposures no further protection is needed for the optical system. Where the reaction is to take hours of continuous heating it is our practice to introduce a moving slide of heavy sheet aluminum over the sheath and under the objective, the slide covering the little furnace at the completion of each exposure. This is arranged to function automatically by means of a small, home-made solenoid actuated by contact every time the camera shutter opens.

Thus, in substance, may be seen the essential principles of the apparatus. As described, motion photomicrographs up to 150 diameters may be made of silicate fusions in the act of fusing and in the act of cooling to glass or

crystal. The only real limitation is the life of the platinum which is very short, but in consideration of the value of the results obtained, it may well be discarded after each fusion as part of the raw material cost of the investigation.

The practical working temperature for one observation is limited by the delicacy with which the platinum support is made. The foil breaks long before it melts due to the tension exerted by the springs. If this apparatus be delicately made to serve only to keep the platinum taut against its expansion, fusions may be made up nearly to the melting point of the platinum.

For ceramic body work, the author has had no difficulty in running to cone 12 liquid on the stage. To study the formation of mullite and the solution of mullite in glasses and slags, a more rugged strip of platinum is required and the cost becomes excessive, since there is a decided vaporization loss in the platinum each time it is used at such high temperatures.

For all of the above, it is presupposed that ordinary light will be used. For the most interesting as well as the most valuable of work, it is necessary to use polarized reflected light which involves the introduction of nicol prisms, one in the optical path of the arc light and the other as a cap analyzer over the eyepiece. The results are most gratifying in that contrasts are markedly accentuated.

It will be understood that the illumination of the melting object in all of this apparatus is partially by light reflected from the object and partially by light reflected from the platinum and transmitted through the object. Thus an entirely new vision or perspective of the subject is necessary for the operator who has heretofore worked solely by reflected or transmitted light in the usual apparatus.

IV. Photographic Technique

It has been the aim so far to offer the salient features of the apparatus required with no reference to the purely photographic technique. This phase is discussed separately in order to avoid confusion.

The photography of an object, large, small, or microscopic, by reflected light of ordinary photographic value offers no problem, given good equipment. It is the rendering of highlights, halftones, and shadows in their relative values. This is true whether the photograph be a "still" or a motion picture which is nothing but a series of stills made at definite, periodic intervals of time.

For photographing close-ups of a piece of clay shrinking or warping, for example, it is only necessary to illuminate with some uniform source of artificial light such as a bank of incandescents in a box, which will serve the twofold purpose of lighting the subject and of providing sufficient heat to do the drying.

The opening in the box may well be closed with two pieces of optical plate glass with an air space between them. This little device will keep both glasses and the lens of the camera free from fog which otherwise would ruin the definition. The slow-speed camera is mounted directly over the aperture in the box so that the object is in the field while drying, warping, cracking, etc. Such a set-up will permit a record to be made for several days if desired without requiring the slightest attention on the part of anyone.

So much for straight photography of slowly changing objects at room temperature or slightly higher, illuminated by ordinary Mazda lights. Suffice it to say that panchromatic film should be used and if the color contrasts are delicate, with much yellow, orange, or red, a simple K filter should be used over the lens.

The next step in high-temperature photography is far more exacting in its technology for many reasons, chief of which is the fact that at the start of the picture, straight highlight-halftone-and-shadow photography is being used but as the temperature rises the object itself becomes luminous and the impinging light becomes of lesser and lesser value in affording the necessary contrasts.

The realization of this truth, as a result of several failures, completely and in a simple manner solved the problem. It was realized that as an object, a fire brick for instance, is heated, the first conscious color is a gloomy red. Then bright red, orange, yellow, and still more yellow. The so-called white heat that one reads of on the color-temperature charts does not really exist except to the eye, since the spectroscope shows a tremendous predominance of the red in all heated objects examined by the author at temperatures up to cone 32.

The relative luminosity in such a heated object increases tremendously as the temperature increases, and with the increase in luminosity comes increasing difficulties in the photography of the object, since it is necessary practically to destroy this self-luminosity and to photograph by means of the light reflected from the surface of the object. This is done in order to afford sufficient contrasts to make a recognizable photograph.

Fortunately, the modern materials available in photographic emulsions give exactly what is required. Since the predominating color that must be absorbed is yellow (emitted by the self-luminous object), a sharp-cutting deep blue filter such as Wratten L or No. 50 is used over the lens. The object is illuminated by intense light from an arc spotlight, using carbon electrodes that give an arc rich in the blue end as compared with Mazda, which light is deficient in blue for this purpose.

The film to be used in such a case should not be panchromatic but should be the usual commercial emulsion in which the blue sensitivity is far higher than the red. Thus it will be seen that by two means, *i.e.*, the absorbing

filter cutting out the yellow, and the highly blue-sensitive film, the self-luminosity of the object is minimized as it is being heated. The resulting photograph does not look to the eye as though the object were being heated at all except for a gradual increase in the brilliance of the lighting.

Thus it will be seen how the photographs of a fire brick being heated under load at high temperature may be made. The camera is equipped with a telephoto lens that enables a relatively small aperture in the furnace wall to be picked up full size at some distance from the furnace. Through this aperture may be focused the object under treatment. Another aperture at an oblique angle to the first admits the beam from the arc lamp which picks out the object clearly against the furnace wall.

Such studies made upon several brick in the same furnace with a really good telephoto lens and an optical flat filter (or plain gelatin filter) are of extreme value, since the actual failure of the texture, grain-by-grain, can readily be recorded if sufficient care is used in focusing. Herein lies the value of the precision type of equipment which enables such focusing to be done through a microscope eyepiece to bring out maximum detail.

V. Photomicrographic Technique

Precisely the same principles obtain in the application of the idea to photomicrography at high temperature, and incidentally the difficulties multiply as the cube of the magnification.

The apparatus has been described previously, but the filter has been neglected in order to place it where it properly belongs, *i.e.*, in the purely photographic section. It is not possible to obtain a cemented gelatine filter for use over the furnace sheath to absorb the yellow, and neither can plain gelatine be used there owing to the heat. Either the plain gelatine may be used or a B-glass cemented L-No. 50 filter over the aperture in the motion picture camera. This position is perhaps the most satisfactory since the slightest distortion of a filter over the microscope lens degrades the image tremendously.

There is one other way out, however, that may prove as useful. The Swiss glass filters may be obtained in a deep blue-violet that is sufficiently sharp-cutting to serve as an actual cover for the little refractory sheath of the thermal stage and for the recording of a refractory melt at extremely high temperature. A chip of one of these blue filters will afford sufficient protection to the objective to enable an extra 100° to be reached on the platinum by virtue of the absorption of the red rays coming from the stage. Definition is degraded, but that extra temperature repays the loss in photographic perfection.

As in the case of the direct motion pictures of heated objects, the film to be used for thermal photomicrography is the blue sensitive stock, not the

panchromatic, since the effect of the self-luminosity of the heated object should be held back as far as possible.

VI. Summary of Results Obtained

The apparatus and technique described are in almost daily use in the author's laboratory. Many observations are made without photographing, since the cost of the film precludes the making of casual records.

The melting behavior of clays of given analysis but varying mineral composition is observed. The solution of grains of clays, grogs, etc., in various slags is studied. The correlation of particle size, pore size, and slag activity is thus made possible. The design of the necessary body structure to accomplish a given result is based upon such observations.

The shrinkage, warpage, and overall drying and firing properties of clays are observed and recorded. From the exact data thus secured, certain clays have been determined especially suitable for high-temperature cements when admixed with certain other nonplastics that had been studied in connection with the clays.

The influence of particle size and composition on the load-bearing value of clay-bonded refractories was studied, demonstrated by analogy, and proved in practice from a formula written beside the thermal microscope and applied to a close-up picture of brick heated while under load.

The physical behavior of cyanite, sillimanite, pyrophyllite, and many similar minerals has been studied at temperatures close to their melting points. The failure of the platinum prevents the actual observation of the latter, but in combination with certain suitable fluxes, melting and reformation can be observed.

The change of the silica minerals is easily observed and recorded especially with polarized-reflected light. The alpha to beta reversible reaction is beautifully depicted. The effect of particle shape on this phenomenon has been studied.

The exudation of glass from artificial aggregates for porcelain and the absorption of glass by others have been studied and these properties have been developed into commercial products.

The melting behavior of feldspars has been observed and substitutes for feldspar with lengthened range of vitrification have been developed. The influence of particle size, shape, and percentage of impalpable flour is of profound importance and the vision of the function of such physical characteristics has greatly facilitated an understanding of the subject.

The use of the film records in educational channels is now of recognized value. Even the men who are in daily contact with the properties delineated seem to gain something from each new showing of the reels.

VII. Commercial Utility

It is unlikely that the results of the three years' use of the technique will

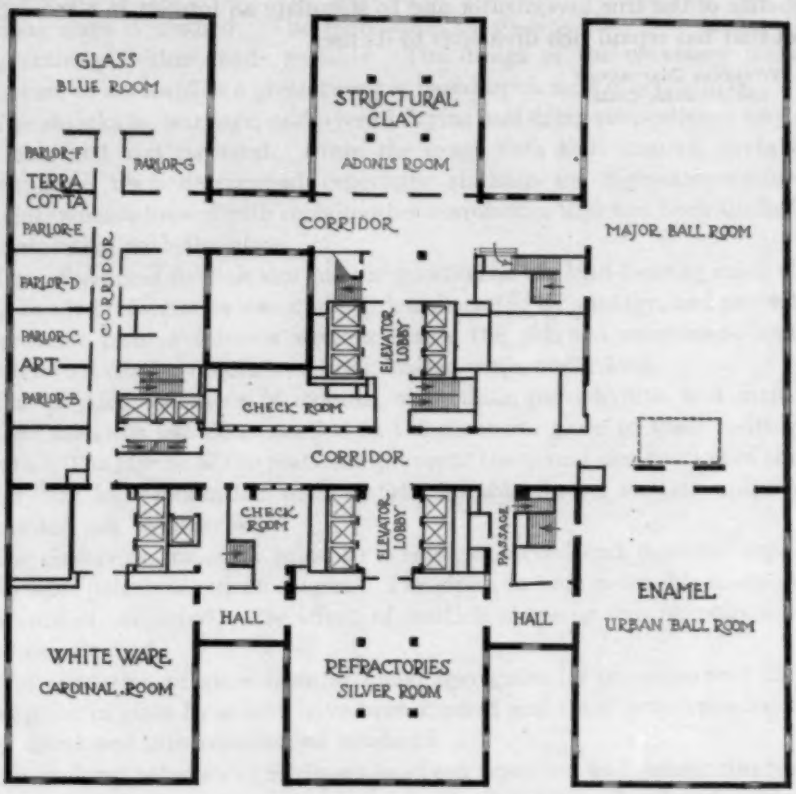
fully be felt in the market for as many more years. The data being recorded are fundamental, and as such will have slow recognition and adaptation. Certain it is, however, that the use of motion picture records of ceramic and refractory substances, bodies, and structures, at room temperature, drying, watersmoking, and vitrification, through the microscope and through the camera eye, will not be permitted to rest at the point to which our efforts have carried them, but will be taken far beyond the few suggestions embodied in this paper, the object of which has been to whet the appetite of the true investigator and to stimulate an interest in a research tool that has repaid rich dividends to its user.

VITREFRAX CORPORATION
LOS ANGELES, CALIF.

ACTIVITIES OF THE SOCIETY

SPECIAL ANNOUNCEMENTS

(1) Authors Furnish Drawings Hereafter the authors of papers will be asked to furnish drawings on white paper (tracing paper or cloth preferred) ready for size reduction and reproducing for the *Journal*. The reductions must be to as small a size as possible consistent with clearness. The lettering must be



The Hotel William Penn Seventeenth Floor Meeting Room Layout

vertical and in lines no heavier than the lines of the drawing. It must be large enough to be reduced legibly with the reduction of the drawing.

(2) No Reprints Hereafter the authors of papers will not be furnished free reprints. The reprint prices are small but they aggregate to a large sum which the SOCIETY has heretofore shouldered to extend its services.

(3) Annual Meeting Registration Fee A fee of two dollars will be charged at the Pittsburgh Meeting next February as was charged in Washington.

(4) 1933 Summer Meeting A Summer Meeting will be held in Chicago during the "Engineers' Week," June 25–30, 1933, in connection with the Century of Progress.

(5) 1933 Annual Meeting The 1933 Annual Meeting of the SOCIETY will be held the week of February 12 at the William Penn Hotel, Pittsburgh, Pa. Here is the meeting room floor plan. The Materials and Equipment Division will hold their sessions in the Aero Club Room on the Club Room Floor.

ANNOUNCEMENT BY CHAIRMAN OF FELLOWS

At the recent meeting of the Fellows of the AMERICAN CERAMIC SOCIETY in Washington, it was decided to make certain changes in the Constitution of the SOCIETY governing the Fellowship and in several items within the Fellowship rules. Among other things, the nomination blank is to be changed in order to eliminate the personal application feature as it is now the policy of the Fellows to have the applicant's name and record presented by a set of sponsors rather than by personal application.

The application blank in its present form will no longer be used. Nominations of the outstanding men in each Division are to be presented to the Fellowship Jury by the Division officers.

These nominations are to be accompanied by a complete history of the candidate's accomplishments together with other material supporting the qualifications of the nominee. The jurors can give proper judgments only when supplied with complete supporting data.

G. A. BOLE, *Chairman of the Fellows*

MINUTES OF EXECUTIVE COMMITTEE, BOARD OF TRUSTEES, AMERICAN CERAMIC SOCIETY, APRIL 8, 1932

Board members present: E. P. Poste, W. K. McAfee, J. M. McKinley, A. Silverman, F. C. Flint, H. B. Henderson, R. C. Purdy.

(A) Committee Appointments Made

(1) *Chairman of Membership:* George W. Denison
(2) *Chairman of Research:* Erwin Sohn
(3) *Chairman of Data:* L. C. Hewitt
(4) *Chairman of Education:* Homer F. Staley
(5) *Chairman of Standards:* A. S. Watts
- E. Ward Tillotson, T. A. Klinefelter, M. E. Holmes } Definitions
- E. C. Hill, H. M. Kraner, George A. Bole } Raw Materials

(6) *Chairman of Sections and Divisions:* T. S. Curtis
(7) *Geology:* W. M. Weigel (to name 4 others)
(8) *Rules:* L. E. Barringer
(9) *Publications:* J. T. Littleton, *Chairman,* Louis Navias, A. E. R. Westman, Louis J. Trostel
(10) *Management:* W. Keith McAfee

(11) *Representative, Color Council:* Walter P. Suter
(12) *Representative, American Association for the Advancement of Science:* E. W. Washburn
(13) *Representative, Federal Specifications Board:* W. K. McAfee
(14) *Representative, Paving Brick Specification:* O. W. Renkert
(15) *Orton Ceramic Research Foundation Trustee* (3 years): J. M. McKinley

(B) Financial Report

(1) Moved by McKinley, seconded by Flint, that the Budget for the quarter (April–July) shall be:

Publications	$3000	Travel	$ 60
Abstracts	400	Depreciation	60
Editor's Office	250	Bad Accounts	50
Salaries	3100	President	10
Secretary's Office	300	Annual Meeting	230
Postage	400	Miscellaneous	100
Rental	240	Total	$8200

(2) Separate bonds for Treasurer and Secretary were authorized. (Bonds have been executed, cost about $30.00.)
(3) Honorary Member certificates were ordered. Cost $9.00 each. (Now being made for Schott, Mellor, Day, Washburn, and Storer.)
(4) One DoMore chair ordered purchased, cost $22.00, charged to capital investment.
(5) Two equipment of type for multigraph ordered, cost $20.00, charged to incidental expense.
(6) Bill of Richard F. Bach, $39.83, ordered paid, charged to Art Division.
(7) Continuing with the Hall-Insley Phase Diagram paper was approved, drawings charged to editor's office expense.

(C) Publications Report

(1) Report of special committee (Kelsey, McKinley, and Schramm) on publications was read. It was ordered referred to Publications Committee (Littleton, Navias, Trostel, Westman, and Purdy), to be studied by them for formulation of policies to be submitted to the Board of Trustees. The following suggestions were made:
(*a*) That canvass be made of possibilities of securing services of a person to be devoted to solicitation of advertisements.
(*b*) That the *Journal* and *Abstracts* be published together in monotype, each with its own pagination and indexed as at present, without advertisements.
(*c*) That the *Bulletin* be issued separately in linotype, carrying advertisements, size 11 x $8^1/_2$ inches.
(*d*) That the *Bulletin* carry a subscription of $2.50.
(*e*) That $2.50 from the member's dues be allocated as subscription to the *Bulletin*.
(*f*) That the advertising rates now prevailing for the *Journal* be the rates for the *Bulletin*.

(D) Meetings

(1) It was unanimously decided not to have a general Summer Meeting in 1932, but rather to encourage the Divisions each separately, as does the Glass Division, to arrange a Summer Excursion Meeting.
(2) Invitations to attend the Glass Division Summer Meeting at Old Point Comfort will be issued to members of the SOCIETY.
(3) Invitation of New Jersey Clay Workers' Association executive committee, dated April 6, by George Brown, Secretary, to hold a joint Summer Meeting in Atlantic City was read. A vote of thanks was unanimous.
It was also voted that this invitation would be accepted for the week of June 19 in Atlantic City, concurrent with meetings of the American Society of Testing Materials.
(4) It was unanimously agreed to accept an invitation of joint committee of American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical

Engineers, and Western Society of Engineers, to hold a Summer Meeting in Chicago, week of June 25, 1933, designated as "Engineers' Week." This invitation was issued through Edgar S. Nethercut, Secretary, Western Society of Engineers, dated March 4, 1932.

(E) Coöperation with Other Organizations

(1) Communication dated February 29 from Advisory Management Corporation, Integrity Building, Philadelphia, by Wm. P. Barba, was referred to Management Committee.

(2) The Executive Committee decided that the SOCIETY shall not at present take association membership in Color Council, but will advise Walter P. Suter to take a personal membership.

(3) It was unanimously approved that Secretary Purdy should follow through with the Chicago Exposition in (*a*) industrial arts, (*b*) science, and (*c*) text-books, but not to incur expense incident thereto.

(4) It was unanimously agreed to inquire into possibilities of appointing an official representative in England.

(5) It was agreed to accept payment of dues from Canada and England on Canadian dollar and English pound basis, the SOCIETY to absorb the exchange rate.

(6) Greetings and congratulations were voted to be extended to the Canadian Ceramic Society.

(F) Status of the Society

The following informational data were presented to the Committee in addition to the March financial reports:

(1) The A.R.I. folder in reference to a financial rebate claim was referred to Mr. McKinley for judication.

	Proposed budget for year	1/4 of budget	Expenditures for 3 months
Cost of Publication	$20000.00	$5000.00	$3856.38
Abstracts	1800.00	450.00	479.84
Editor's Office Expense	1250.00	312.50	796.19
Salaries	13000.00	3250.00	3111.25
Secretary's Office Expense	1700.00	425.00	440.32
Postage	1250.00	312.50	360.22
Office Rental	1080.00	270.00	250.00
Traveling Expense	500.00	125.00	38.13
Depreciation	250.00	62.50	57.00
Bad Accounts	200.00	50.00	48.00
Reprints	No allowance		84.21
President's Office Expense	No allowance		4.90
Annual Meeting*	No allowance		221.41
Miscellaneous	No allowance		139.40
Committee	No allowance		
Total	$41030.00	$10257.50	$9887.25

* Through March $885.65 were spent on Annual Meeting. The figure shown above ($221.41), however, is that which has been allocated for the first three months. The balance ($664.24) is a deferred expense.

MEETING OF THE JOINT COMMITTEE ON FOUNDRY REFRACTORIES[1]

The meeting of the Joint Committee on Foundry Refractories was held in Chicago, May 5, 1931, in conjunction with the A.F.A. convention. The members present were as follows:

[1] For complete Committee personnel see *Bull. Amer. Ceram. Soc.*, **10** [6], 190 (1931).

Chairman, L. C. Hewitt	H. J. Hoff
Secretary, J. L. Cummings	S. S. Feldman (visitor of the Amtorg Trading Corporation, New York, N. Y.)
H. M. St. John	P. H. H. Dunn (Bureau of Standards)
W. Harvey Payne	H. L. Smalley
Major Bull (visitor)	H. C. Elliott
E. E. Marbaker	A. G. Gierach
James R. Allan	

The minutes of the last meeting held March 8, 1930, were read and approved.

The next subject of the meeting was new by-laws which had been drafted and submitted to the various members of committees and sub-committees. The by-laws were passed around to the members present for discussion.

The membership list of the present committees and sub-committees was read by Secretary Cummings. The layout of the new by-laws was also read and they were declared proper and sufficient.

L. C. Hewitt was reëlected chairman of this Committee and James R. Allan, International Harvester Co., was elected vice-chairman. Mr. Hewitt then called for the committee chairman's report and reports from the sub-committees.

Mr. St. John of the Nonferrous Committee stated that his committee has felt that it is an almost impossible task to simplify and standardize on shapes for furnace linings for the non-ferrous industry. This committee has collected data on cement, ramming mixtures, etc., and has published some reports in *The Foundry* and other publications pertaining to the industry. All of the reports are not yet completed, such as the lining of electric furnaces, etc.

One of the most striking developments of Mr. St. John's committee was the accumulation of data from various foundrymen which showed such a difference in character and application that only a few seemed to be getting the very best results, and the committee is endeavoring to broadcast the data they have collected to such foundries not obtaining good results.

Several of the items Mr. St. John discussed pertained to direct-flame improvement from surveys over 1926.

It was suggested that Mr. St. John's committee include the brass melting cupola in the survey of the coming year.

No report was presented from Mr. Reese's Committee on Stoppers and Nozzles.

Major Bull stated that there was no report ready as yet on the recent meeting of the Foundry Standardization Committee of the American Standards Association in New York. It seemed desirable that the Joint Committee on Foundry Refractories should have representation on the A.S.A. committee because of their interest in standardization of foundry materials and supplies.

In Mr. Allan's report for the malleable industry, he stated that the attention of the division has been given largely to publicity on standard shapes and to the matter of tolerances for such shapes.

Dr. Marbaker's report of the Cast Iron Committee is attached. He stated that the American Refractories Institute had an excellent line-up on cupola blocks as per the A.R.I. standards and suggested that these standards be adopted. This committee is issuing a new questionnaire pertaining to tap-out and slag-hole blocks, a report of which will be made at the next meeting.

The next report on the electric furnace, by Harvey Payne, *Chairman*, follows.

Respectfully submitted,

J. L. CUMMINGS, *Secretary*

Report of Work Done by Sub-Committee on Gray Iron Foundry Refractories

In October, 1930, E. E. Marbaker, Chairman of the Sub-Committee on Gray Iron Foundry Refractories of the Joint Committee on Foundry Refractories, sponsored by

the AMERICAN CERAMIC SOCIETY and the American Foundrymen's Association, contacted with the Division of Simplified Practice of the Bureau of Standards.

Dr. Marbaker suggested that inasmuch as this Division had coöperated with a committee of similar status as his in the malleable foundry industry, it might be able to be of some assistance in any work that he might undertake. After an exchange of correspondence a representative of the Division of Simplified Practice met with Dr. Marbaker's committee in Pittsburgh and the entire matter of possibilities of simplifying cupola lining blocks, as well as tap-out and slag-hole blocks, was discussed in detail. It was decided that the most logical procedure in this case would be to circularize the refractories manufacturers with the idea of ascertaining the variety of sizes and shapes of the above-mentioned blocks produced by them.

The Division of Simplified Practice circularized some 150 firebrick manufacturers and obtained a wealth of data. These data were submitted to another meeting of the Sub-Committee on Gray Iron Foundry Refractories.

After a careful discussion of the data on hand, it was decided to divide the committee's recommendations into two parts. The first part would deal with the cupola lining blocks themselves. In this connection the survey had revealed that the American Refractories Institute standard sizes and shapes were in common use throughout the trade. It was, therefore, deemed desirable to use these sizes and shapes as a basis for that part of the recommendation which had to do with the ordinary lining of the blocks. The second part of the recommendation was to cover tap-out and slag-hole blocks. The information in hand regarding these materials was inadequate and could not be used as a basis for a representative recommendation. It was therefore decided by the committee that the Division of Simplified Practice should make a further survey in an effort to obtain data which could be used for a recommendation covering tap-out and slag-hole blocks. At this date[2] that survey is under way and immediately upon receipt of sufficient information to be used as a basis for a recommendation, this information will be submitted to the committee of which Dr. Marbaker is chairman.

Report of the Sub-Sub-Committee on Survey and Standardization for Electric Melting Furnaces in the Ferrous Industry[3]

Your Committee on Survey and Standardization for the Steel Casting Industry submits the following report:

(1) This Committee has been functioning so far largely on the study of electric furnace refractories, although it is classified to study refractories for the electric steel castings industry.

(2) Two years ago 160 questionnaires were sent out to electric furnace operators. This questionnaire was designed to bring out all possible points relative to refractory shapes and sizes. The net result of some 40% replies to this questionnaire was to show that there are very few furnaces of even similar size, which operate under conditions close enough to warrant trying to standardize on refractory shapes. In addition to this the electric melting furnace is being changed to improve efficiencies and is being adapted to new uses, all of which lend to the opinion that broad standardization of these shapes is rather impractical at present.

(3) A great deal of attention is now being given to the adoption of standard manufacturing tolerances of fire brick.

(4) This Committee has studied this subject as related to the manufacture and use of silica shapes for electric melting furnaces. It is understood that producers are at present working to a size tolerance of ±3% on linear dimensional variations due to shrinkage and warpage of 4 inches or less, and ±2% for over 4 inches.

(5) The members of this Committee agree that the best equipped producers are

[2] May 2, 1931.

[3] By W. H. Payne, Pittsburgh Electric Furnace Corp., Chicago, *Chairman*, to J. R. Allan, *Chairman*, Sub-Committee on Survey and Standardization.

now making brick better than these tolerances and that closer tolerances as demanded by the large refractory users are being met also. The last tolerances are given in the form of plus or minus fractions of an inch allowable variations from a given dimension for both shrinkage and warpage.

(6) It is the opinion of this Committee that this tolerance should be simplified to a statement of a plus or minus variation in percentage of given dimensions, and we therefore recommend a tentative plus or minus tolerance of 1.2% of specified right angle face dimensions for so-called standard silica shapes.

(7) While it is felt that improvements along these lines are a part of the program of the producers, and that the tolerances recommended are just a step ahead of present practice of the best producers, the fact must not be ignored that some small refractories users will take advantage of these closer limits and possibly reject brick, the actual use of which would not be affected by small variations. For instance, in laying up electric melting furnace side walls, it is the opinion of this committee that the above tolerances are closer than necessary for width and length dimensions. Close *stacking* dimensions are important here. For electric furnace silica side wall shapes, the committee agrees that the present statement of ten 9-inch straights stacked to an added dimension of 90 inches shall not exceed 90 inches and shall be not less than 89½ inches; this figure ±0.55%, as compared to the recommended 1.2% of the other general dimensions.

(8) The so-called special hand-rammed silica shapes for electric furnace roof refractories are being made by the best producers to closer tolerances now than in the past. This is partially due to the use of rigid metal molds.

(9) The producers' present allowable tolerance for these shapes is ±0.25 inch for face dimensions and warpage. This may seem a total variation of ½ inch in the case of two adjacent brick faces, each being on the plus extreme. With these faces coming approximately 12 inches apart, the summation of such plus extremes would add to make 3 inches over in a 12-ft. diameter roof.

While this will not happen in practice, the example is cited to show the crudeness of such fixed tolerances.

(10) It is, therefore, the opinion of this Committee that tolerances in all shapes should be tied to a plus or minus average allowable variation in a number of joints.

(11) This Committee also wishes to bring out the fact that there are many cases of an electric furnace user who may have a complaint in refractory life and who at once picks out what is to his mind, a weakness in the detail cut-up of certain shapes, and who makes life miserable for his friend the producer to change at once the shapes in some way. If the producer cannot talk the user out of such changes he must, in order to hold the account, go to the expense of changing his metal molds for one customer. Some of these claims are well founded and many of them are not, and the user should keep in mind that such unwarranted changes, while accepted in good grace by his friend the producer, are finally passed on the user simply because they unnecessarily increase the cost.

(12) One set of these metal molds for a fairly large electric furnace will cost around $600.00 and the producers have on hand an astonishing inventory in molds due in part to such changes.

Respectfully submitted,
W. HARVEY PAYNE, *Chairman*
Sub-Sub-Committee on Survey for
the Steel Castings Industry

REPORT OF ENAMEL DIVISION STANDARDS COMMITTEE

BY C. J. KINZIE

(1) Deflection Tentative Method for Determination of the Resistance of Sheet Steel Enamel to Deflection: this method stands as revised in the 1930 report.[1] No action has as yet been taken by the Enamel Division as to its adoption as a Standard Method.

[1] See *Bull. Amer. Ceram. Soc.*, 9 [9], 269 (1930).

(2) Particle Size of Milled Enamel The Proportion of Various Particle Sizes in the 200-Mesh Fraction of Milled Enamel: This subject was proposed by the 1931 Committee as being of possible interest. It is now the opinion of this Committee that this project should be abandoned as there does not appear to be sufficient interest to warrant any work on the part of the Standards Committee.

(3) Corrosion Methods for the Determination of the Resistance of Vitreous Enamel Surfaces to Corrosion: A brief résumé of the Committee's conclusions is given.

(1) The tests should be made on the finished enamelware surface, thus eliminating from consideration the various frit grain solubility tests.

(2) Whatever test or tests may be finally proposed as tentative standard tests should be limited as follows:

The test should be known as a Resistance to Corrosion Test. No mention is made as to the test reagent so that the user of the test is left to his own discretion as to what chemical should be used and also the strength, etc. This would leave the matter broad enough to include acids, alkalis, etc., in the range of test media.

(3) There should possibly be two methods put into shape for submission as tentative. (*a*) One consists of a qualitative method of the spot test type in which the details of technique are given and (*b*) a test consisting of an adaptation of the test on loss in weight used in enameled hollow ware tests. In this test the enamel is deposited inside a suitable shape and connected to a water-cooled reflux condenser to keep the volume of test reagent constant, and the test vessel is weighed before and after the test. This method could be used qualitatively.

In connection with the second proposal there is a question as to whether it is of sufficient importance to enamel manufacturers to warrant the Committee's attention. It is also noted that in order to be quantitative the vessel used would have to be small enough to weigh on an ordinary analytical balance, which would limit the usefulness of the test since it is preferable to test ware of the sizes produced. A special shape would involve special work and it is questioned whether, in view of the numerous methods available, an additional one is needed.

Murray C. Gautsch has made a thorough review of the literature on the subject of corrosion resistance. A copy of this report is appended hereto.

It is hoped that a proposal can be made for a tentative qualitative method of testing. Nothing will be ready as to a tentative quantitative method, as this subject requires more study and also a decision as to whether it is a subject for the Committee to consider.

The various members of the Committee as well as the Chairman of the Enamel Division (Mr. Rice) have presented many valuable suggestions along this general line. A brief résumé of these suggestions follows:

In connection with the spot-type test, the suggestion has been made that panels might be prepared with cuplike depressions to hold the reagent. This would enable the confinement of the test area and keep the surface moist.

A dye solution might be used to stain areas affected with the test reagent so as to bring out a slight attack not easily seen by the eye.

The use of a glarimeter has been suggested as a means of measuring the loss in luster of tested areas.

Some porous inorganic material could be used to hold the reagent in contact with the enamel surface during the test.

In making corrosion tests the fluid testing medium may be placed in a test tube and inverted onto the surface to be tested. This keeps the reagent in fluid contact with the enamel surface for any time desired since the reagent cannot dry up. This method has proved to be satisfactory. This inverted test tube has the advantage that there is little or no change in the concentration of test fluid during the test whereas in the various other spot tests evaporation takes place and the test reagent becomes more concentrated

in most cases. If water is used for moistening, the reagent may become less concentrated. It must be admitted, however, that the simple modifications of the spot test serve as a reliable means of differentiating the corrosion resistance of enamels.

(4) Mechanical Impact This subject was proposed as being of interest to the Enamel Division. It was concluded that there are available in the literature detailed descriptions of machines suitable for this purpose and in view of the fact that several different styles of machines are evidently giving satisfactory results it would hardly be worth while at this time for the Committee to attempt to decide upon any one machine as standard. To reach a decision would involve a considerable amount of expense and work and until the demand for such a standard becomes more pronounced, it is suggested that this matter be allowed to rest.

(5) Thermal Shock Some interest has been expressed in this subject. The method as presented in 1931 appears to have merit as a testing method.[2]

It has been suggested that interesting results might be obtained by subjecting 12- by 2-inch pieces (such as used in cross-bending tests) to various degrees of thermal shock and then testing them in the cross-bending machine. The idea is that temperatures too low to cause failure by thermal shock may weaken the enamel so that a different failure reading would register in the cross-bending test.

Modification of thermal shock test seems to be a good field for investigation. It would be well to decide whether there exists sufficient interest to warrant the Committee investigating the problem of resistance to thermal shock.

(6) Abrasion Several methods for this purpose have been presented, but none seems to have fulfilled all of the requirements of a simple, quick test such as would be needed by the trade.

Dr. Andrews of the University of Illinois has a student working on one type of apparatus and although the work has not progressed far enough to warrant a positive statement, it seems that the method he is using will give satisfactory quantitative results.

The manufacturers of finishes other than vitreous enamel have been giving this subject considerable study and one machine[3] in particular has been developed which has proved satisfactory for testing abrasion resistance of lacquers. The results show that the machine is a good one. The writer believes that, with some modifications as to air pressure and size or type of abrasive, quick tests could be obtained on vitreous enamel surfaces. During the past year preliminary tests have been made on similar apparatus. It has been shown that abrasion sufficient to cloud the originally lustrous vitreous surface can be produced in one hour and inasmuch as there appears to be no question of controlling the amount of abrasive delivered and also no question as to ability to control positively the air pressure at a set point, the method should prove capable of yielding reliable as well as reasonably quick results as to resistance to abrasion.

Work along this line might well be continued and it is suggested that the Standards Committee keep this subject on its program.

(7) Fusion Flow Properties This general subject has received a considerable amount of study by this Committee.

Dr. Andrews reports that he has done some work on heating small chips of enamel glass and watching the effect under the microscope as the temperature is increased. Since the surface tension of the enamel plays such an important function in this change it is doubtful whether this test will ever be completely satisfactory.

Mr. Sweo has submitted a comprehensive analysis on fusion properties and his report follows.

---

[2] See *Jour. Amer. Ceram. Soc.*, **15** [2], 112–15 (1932).
[3] See article by Wm. Koch, *Ind. Eng. Chem.* [Analytical Edition], Oct. 15, 1930.

Fusion Properties[4]

In the selection of a test to be used as a Standard Test of the Fusibility of an Enamel, one that is to have wide commercial application, the following points must be borne in mind:

(1) The test should be one that can be evaluated quantitatively. (2) It should have a definite point or points at which the quantitative evaluation units may be applied. (3) It should be a test giving reproducible results. (4) It should be fast. (5) It should be simple.

The three most common fusibility tests used today are as follows:

(1) Cone Deformation Test.
(2) Fusion Block Test.
(3) "Button" or Cylinder Test.

Other types of tests are employed but in principle they can be classed as similar to one of the above-mentioned tests. For example, the Panel Rack Flow Test is readily comparable to the Fusion Block Test.

Another vital factor to be considered is that in conducting a fusibility test it should be carried out over a range of temperatures rather than at a constant temperature. This would seem to introduce another variable, but if the rate of heating is conducted according to a definite schedule the time-temperature conditions are constant and when the end point of the test is reached it can be evaluated in terms of these units.

Some difficulty is experienced in maintaining a constant temperature. This, however, is not the principal objection to conducting fusion tests at constant temperature. It is well known that enamels behave much differently at different temperatures; for instance, the fusibility may be a straight-line function of the temperature up to 500°C. Above that temperature there may be a marked increase in the degree of flow, that is to say, above 500°C the fusibility of the enamel is an exponential function of the temperature. Another enamel may behave similarly but may differ as to the temperature at which the marked ease of flow begins. Suppose the temperature in the case of the second enamel is 600°C. Now consider the case of comparing these two enamels. At any temperature below 500°C (assuming that the enamels will flow below that temperature) they may show the same fusion characteristics; above 500°C the first enamel may be much more mobile than the second. At a temperature above 600°C the second reaches its point of increased mobility and will approach or may even surpass flowability of the first enamel. Consequently, an observer comparing these two enamels at a constant temperature may be led to erroneous conclusions inasmuch as their difference in behavior at that temperature may not be the same as at some other temperature. If they are heated, however, throughout a range of temperature they will behave according to all conditions encountered and their behavior will be more indicative of their true fusion behavior than at any definite temperature.

Comparing the three tests mentioned on the basis of the five points to be used as criteria and ranking them afford a good basis of selection:

(1) Cone Test: (1) can be evaluated quantitatively; (2) has a definite end point; (3) is not readily reproducible; (4) is not so fast; and (5) is quite simple.
(2) Block Test: (1) can be evaluated quantitatively; (2) has a definite end point; (3) is readily reproducible; (4) is fast compared to cone test; and (5) is quite simple.
(3) Button Test: (1) cannot be quantitatively evaluated readily; (2) has no definite end point; (3) is easily reproduced; (4) is very rapid; and (5) is not so simple.

Quantitative evaluation	Definite end point	Reproducibility	Speed	Simplicity
Cones	Cones	Buttons	Buttons	Blocks
Blocks	Blocks	Blocks	Blocks	Cones
Buttons	Buttons	Cones	Cones	Buttons

[4] Report of B. J. Sweo, Bureau of Standards, Washington, D. C.

Assigning a weight of 5 points to first place, 3 points to second place, and 1 point to third place, various tests score as follows: Block 18, Cone 14, and Button 13. According to these criteria the Block Test is more suited to adoption as a standard test.

The details and procedure of the test as used by the writer are given below.

The fusion block used in this test is known as the "feldspar fusion block" and has been in use for several years as a test instrument in determining the fusion properties of feldspars. Recently, however, its adaptability to other uses has brought about its use in determining the fusion properties of other ceramic materials, notably enamels and glazes.

The block is of porcelain and consists essentially of an inclined plane with ruled lines across its surface, above which is a compartment in which the material to be tested is packed.

The powdered frit (200-mesh) is moistened with a little water, packed into the compartment of the block, and smoothed off even with the face of the block and the face of the orifice at the bottom of the compartment. The frit can also be packed in dry and heated to a temperature such that sintering takes place, thereby insuring the frit remaining in the compartment. This method of packing has been tried and appears quite satisfactory. In the majority of tests conducted, however, the moistened frit was used. The frit is allowed to dry and the block with its load is placed in a furnace (at 600°C) at an angle of 45° to the line of vision of the observer. A thermocouple is placed in the furnace in such a way that when the block is inserted the bead of the couple comes to the mouth of the compartment and about one-quarter inch away from the block. The temperature drops momentarily but soon regains to 600°C when a heating schedule of 3° per minute is followed until the test is completed. As the temperature rises the frit fuses and flows down the face of the block passing ruled lines on the inclined surface. The temperature and time at which the flowing column of frit passes each ruled line are recorded and taken as measures of the fusibility of the enamel. The block is removed from the furnace when the last ruled line is reached.

Conclusion of Report by Mr. Kinzie

It is thought that possibly the more recently developed tests, namely, the Button and Fusion Block Tests, should be classed as additive tests and not with the Cone Deformation Test.

The Cone Deformation Test gives valuable information up to the point where enamel barely begins to flow, whereas the newer tests give information past this point, and therefore would not necessarily replace the Cone Deformation Test.

(8) Sieves for Testing Purposes

The American Standards Association in coöperation with the A.S.T.M. and the Bureau of Standards has undertaken the problem of Standard Specifications for Sieves for Testing Purposes. The AMERICAN CERAMIC SOCIETY has been asked to coöperate.

The idea is to attempt first to standardize sieves and testing methods within the United States and evidently later to coöperate with other interested countries along the same line.

(9) Standard Specifications for Flint, Feldspar, and Fluorspar

No definition or data pertaining to grades, etc., has been presented for use by trade in purchase of fluorspar. In case of flint, Purchase Specification for Flint (Tentative) has been made,[5] but no definition or data indicating grades have been specified as have been done for feldspar.

The Committee has been asked to consider these two matters.

ACID RESISTANCE OF ENAMELWARE

By MURRAY C. GAUTSCH

After reviewing the literature on tests for acid resistance of enamelware, it seems reasonable to classify these tests under three headings, namely: (1) loss in weight of

[5] See *Bull. Amer. Ceram. Soc.*, **2** [6], 166 (1923).

finished ware, (2) loss in weight of frit, and (3) spot test on finished ware. Variations of these tests have been advanced at various times during the last fifteen years as standards for testing the resistance of enamelware to acids.

The first work done on testing the resistance of enamelware to the action of acids appearing in the literature of the AMERICAN CERAMIC SOCIETY was done by Edward Orton, Jr.[1] General Orton presented the work done in testing automobile license plates for the state of Ohio. The plates were weighed and put in a boiling solution of 1 part sulphuric acid and 99 parts of water. The per cent loss in weight after 15 minutes in the solution was calculated. In another test the license tags were placed for eighteen hours under a bell jar with a beaker of strong hydrochloric acid. The plates were weighed before and after exposure to the acid fumes and the per cent loss in weight was calculated. From this report the state of Ohio adopted a tentative requirement that manufacturers of license plates were to meet (1) 1.5% maximum solubility in sulphuric acid of the strength noted after 15 minutes boiling, (2) 0.50% maximum loss after exposure to hydrochloric acid vapors for eighteen hours and washing off in distilled water.

In 1910 J. B. Shaw[2] presented a method for testing the solubility of sheet steel cooking utensils.

Select pieces of the same shape and size and of such shape to permit easy measurement. Wash each vessel with distilled water and weigh accurately to 0.001 gram. Then fit a rubber gasket into the top of each vessel; the gasket must fit firmly to the pan so as to exclude acid from working up behind it. Fill the pans to be tested with distilled water and heat to boiling. In a glass vessel heat to boiling 1 part 1.84 sp. gr. sulphuric acid and 99 parts distilled water. When the water in the vessel is boiling pour out and pour in the boiling acid solution filling the pan above the level of the gasket. The acid solution is boiled vigorously for 15 minutes. Pour out the acid, fill with boiling water, and then run cold water into the vessel until the pan is cooled. Remove the gasket, dry the pan, and weigh the dish carefully. The total loss in weight is divided by the area of the dish and the loss reported in grams per square inch. This test falls under Test 1.

R. D. Landrum, in 1911, advanced a test[3] for the resistance of enamels to acid and which falls under Test 1.

Nineteen dishes were coated in each of two enamels, one enamel being resistant to acid attack. After weighing the dishes to $^1/_{10}$ milligram, solutions varying from 1 to 100% acetic acid were placed in them and were then evaporated to dryness by placing on a hot plate. When dry the dishes were washed, dried, the surface of the pan rubbed and again weighed to $^1/_{10}$ milligram. The losses in weight of enamel were plotted against the per cent of acid used. In a discussion of this paper, it was pointed out that although in dilute solutions the acid is more dissociated than in concentrated, this means only that more action will take place in a given time per unit of acid and does not mean that the more highly ionized acid is capable of dissolving more enamel if the reaction were allowed to come to equilibrium. It was also brought out in the discussion that in boiling the solutions the more dilute the acid the longer the time in which active concentrations would be operating.

E. P. Poste[4] presents a method (which falls under Test 2) for testing the resistance of powdered enamel to the action of different acids.

Two grams of a frit ground in a pebble mill and which passed a 50-mesh sieve were weighed in a 400-cc. beaker, 100 cc. acid were added, and the contents of the beaker

[1] E. Orton, Jr., "Testing of Enameled Sheet Steel Ware," *Trans. Amer. Ceram. Soc.*, **11**, 320 (1909).

[2] J. B. Shaw, "Testing Sheet Steel Enamels," *ibid.*, **12**, 463 (1910).

[3] R. D. Landrum, "Resistance of Sheet-Steel Enamels to Solution by Acetic Acid of Various Strengths," *ibid.*, **13**, 494 (1911).

[4] E. P. Poste, "Relative Action of Acids on Enamel," *ibid.*, **17**, 137 (1915).

thoroughly stirred and allowed to stand twenty-four hours at laboratory temperature which was constant. The frit was recovered by filtering through a weighed Gooch crucible. The loss in weight was determined by subtracting the weight of frit retained from the original weight.

The objection to this method was that in frits of varying specific gravities the surface exposed varied inversely as the specific gravity. Another objection was that the enamel had been melted only once.

Poste continued the work on the above grain test,[5] conducting a series of experiments which were prompted by the discussion of his previous paper. The size of grain used was limited to that passing through one-mesh screen and retained on the next. The weight of the frits was varied to conform to the specific gravity of the frit so that a uniform surface area was maintained.

Leon J. Frost[6] used the same method as was used by Landrum in testing the ware and his results check fairly well with those of Landrum.

The action of acetic acid on an enamel powder was investigated further by E. P. Poste[7] as well as the action of acetic acid on steel. The same results were obtained as in preceding experiments, *i.e.*, that dilute solutions of acid were more active than concentrated solutions. It was also found that the action of acetic acid near its maximum activity on enamel is subject to various irregularities. This behavior of acetic acid indicated that it was not a desirable acid for a standard. A further objection to acetic acid was that it is a liquid, and an acid which could be obtained in solid form would be a better acid for use as a standard. As both citric and tartaric acids are obtained in the solid form, they were investigated and the following points were brought out: (1) citric and tartaric acids at a given concentration are more active than acetic acid and hence give more definite results; (2) the relative actions of citric and tartaric acids are about equal, (3) the general shapes of the curves for citric and tartaric acids are such as to render slight errors in concentration above 10%. It was brought out in the conclusion that an effort should be made to extend tests to actual enamel surfaces.

E. P. Poste presented a fourth study[8] of acid action on enamels in 1920. In consulting various food chemists, it was found that the consensus of opinion was that citric acid offered the fairer means of testing enamelware. In making up specifications for a standard acid solution, it seemed feasible to adopt English units of weights and measures. Six ounces of citric acid dissolved in one quart of water made a solution of theoretical strength of 15.73% which was adopted as a standard. Dishes were then tested by filling them with the standard acid and letting them stand for 24 hours at temperatures from 12 to 20°C. A quantitative value of the acid attack was obtained by heating the solution left in the pans until dry, igniting, and weighing. The pans exposed to the acid all showed a marked etching. It was decided that this test was too severe as practically all commercial ware would be etched after this treatment. The severity of the test was lessened by lowering the strength of acid used. As the strength of the acid fell below the break in the curve, the action on the enamel fell off rapidly. Some dishes were faintly etched by the more concentrated solutions but it was difficult to determine which dishes showed no etching. This brought up the question of when a dish was etched. A 3-gram per liter solution of malachite green was used to test the relative degree of etching of the dish by putting it in the dishes for five minutes. The relative discoloration was proportional to the etching of the dish.

---

[5] E. P. Poste, "Relative Action of Acids on Enamels," Part II, *Trans. Amer. Ceram. Soc.*, **18**, 762, 927 (1916).

[6] L. J. Frost, "Action of Acetic Acid Solutions of Different Strengths on a Sheet Steel Enamel," *Jour. Amer. Ceram. Soc.*, **1**, 422 (1918).

[7] E. P. Poste, "Relative Action of Acids on Enamels," *ibid.*, **2**, 32 (1919).

[8] E. P. Poste, *ibid.*, **3**, 562 (1920).

J. B. Shaw[9] tested samples of sheet-iron enamel for resistance to acids by placing lemon juice, 10% citric acid, and 10% oxalic acid on the finished ware. Each piece of ware to be tested was washed and dried. Then the solution was dropped on the ware for varying periods of time some ten minutes, thirty minutes, and some allowed to evaporate to dryness. The pieces were rated as to whether they stained, became dull, complete loss of gloss, and finally rough uneven surfaces. This test falls under Test 3.

Homer F. Staley[10] presented a method for testing the resistance to acids of enamelware used for chemical purposes. This method is a qualitative test and is a variation of Test 3. The tests were made by placing the ware on a steam bath and keeping it filled with 20% hydrochloric acid for a period of 1000 hours unless the enamel failed before that time. Every seven hours the solution in the ware was changed to prevent an accumulation of salts in the ware. Failure was determined when the surface of the ware softened sufficiently to permit definitely being scratched with a pointed knife blade. Although this method of testing chemical ware might seem crude it conforms to the methods by which such ware are condemned in use. Loss of weight of an enamel is not a true criterion of its acid resistance because the enamel will take up radicals from the acid and actually increase in weight while the ware is disintegrating.

E. P. Poste[11] has discussed the Bureau of Standards test, which uses a solution of 1% glacial acetic acid and 99% distilled water by volume and at a temperature of 60 to 70°F. The solution is placed in the article to be tested and removed hourly. The piece is examined hourly for loss of gloss or etching, either of which is considered failure of the enamel. The ware is graded according to the time it "stands up" under this treatment. The spot test is given also in this paper which is described as follows:

> Place a drop of acid solution on a horizontal surface of the ware to be tested, allow it to remain one minute, wipe with a wet sponge, and rub lightly with a dry towel. If the enamel has been acted upon a reduction in specular reflection is easily observed at the spot where the acid was applied.

In developing a tentative test for determining the resistance of enamelware to the action of acids, it is evident that one set of specifications for testing all types of vitreous enamelware is inadequate. The use to which various ware are to be subjected governs the nature of the test. For example, in testing sanitary ware, the spot test using a 10% citric acid solution is a fair test because this type of ware is called upon to resist acids of similar character under similar conditions. That is to say, in service a piece of sanitary ware does not have to resist strong acids for long lengths of time but is subjected only to household acids accidentally placed upon it. In this type of ware failure is determined by whether the piece is attacked and not by the degree of attack, while in ware for kitchen use the amount of attack is important as the ware is constantly exposed to food acids and the degree of attack is important. The same applies to ware used for chemical purposes; consequently, in preparing a standard for testing the resistance to acids of enamelware the use for which the ware is intended should be the guiding factor. The grain test is of little value in testing the finished products, as mill additions and firing of the ware have a very marked effect on the resistance to acids of the finished ware. The literature covers very well the work on the degree of attack of various strengths of acids and also the various kinds of acids. The work to be done then is to determine a fair simulated service test for three types of ware: (1) ware exposed to acids occasionally such as sanitary ware, stove parts, refrigerator boxes, etc., (2) ware exposed to weak acids such as kitchen ware, and (3) ware exposed to comparatively strong acids

[9] J. B. Shaw, "Enamels for Sheet Iron," Bur. Stand., *Tech. Paper*, No. 165, p. 81.

[10] Homer F. Staley, "Some Relations of Composition of Solubility of Enamels in Acids," *Jour. Amer. Ceram. Soc.*, **4**, 703 (1921).

[11] E. P. Poste, "Relative Action of Acids on Enamels, V," *ibid.*, **6** [6], 689 (1923).

such as chemical ware. Type 1 would need only a qualitative test while types 2 and 3 would need a quantitative test. Therefore some variety of the spot test is suitable for the type ware covered in type 1 while for types 2 and 3 some variety of the loss in weight test could be used.

METAL AND THERMIT CORPORATION
NEW YORK, N. Y.

QUALITATIVE SPOT TEST FOR RESISTANCE OF ENAMELWARE TO ACIDS

BY MURRAY C. GAUTSCH

This test is based on the use of 7% by weight citric acid solution.[1] The reason for using a 7% citric acid solution is that it is the approximate strength of lemon juice and is a fair simulated test for ware in service. Citric acid is used rather than other acids because it is readily made up by weighing a dry substance and adding water; citric acid is easily obtainable from any drug store and therefore does not present any problem to the shop man who does not have access to extensive laboratory facilities.

The acid used in this test shall be citric acid of 7% strength by weight. The acid shall be applied through the medium of circular disks one inch in diameter cut from ordinary blotting paper. For that part of the test which requires longer contact of acid than one hour, circular disks of filtros one inch in diameter and one-half inch thick shall be used over blotting paper.

The ware to be tested shall be fair specimens made according to the specifications of the individual shop or laboratory.

Eleven circular pieces of blotting paper, one inch in diameter, shall be placed in 7% citric acid and allowed to become saturated. Remove one piece and drain it to remove excess acid, place it at one corner of panel, pressing it to remove entrapped air, leave one minute in contact, remove, and wipe off spot with damp cloth a sufficient number of times to remove acid. Place another disk in the same way and leave two minutes, remove, and wipe off spot as above. Now place the remaining nine disks in convenient order and remove disks in order 4, 8, 16, and 30 minutes and 1, 2, 4, 8, and 24 hours. For all lengths of time beyond one hour a circular piece of filtros one inch in diameter and one-half inch thick is saturated with 7% citric acid and placed on the blotting paper disks. This prevents the drying out of the disks and insures acid contact for at least 24 hours.

The ware shall be graded for acid resistance depending on degree of attack as stainless, stained, or etched, for the period of time it has been exposed to the test. Stainless ware shows no visible attack of enamel; stained shows lessening of gloss but no roughening of surface; etched shows attack on the surface with roughening of the enamel.

CONDOLENCES FROM ORGANIZATIONS ABROAD ON THE PASSING OF GENERAL ORTON

The English Ceramic Society

At a meeting of the English Ceramic Society held on March 14, 1932, the President announced the death of General Edward Orton, Jr., and the members stood in silence for a few moments as a mark of respect.

[1] E. P. Poste, "Relative Action of Acids on Enamels," *Jour. Amer. Ceram. Soc.*, **3** 502 (1920).

I have been requested to tender to the members of the AMERICAN CERAMIC SOCIETY the very deep sympathy of the members of The English Ceramic Society in the great loss which has fallen to you. We, in England, who had the privilege of knowing General Orton personally, knew him as a man of sterling character and charming personality and we mourn with you the loss of a great man.

J. W. MELLOR, *Honorable Secretary*

Deutschen Keramischen Gesellschaft

As president, I desire to extend the sincere sympathy of the German Ceramic Society to the AMERICAN CERAMIC SOCIETY over the death of General Edward Orton, Jr.

We have just learned through the announcement in the March number of the *Journal of the American Ceramic Society* of the great loss which you and your SOCIETY have suffered. Ceramic science and the ceramic industry of the entire world grieve with the AMERICAN CERAMIC SOCIETY in the loss of this man who, as no other, sensed the need for ceramic development. Your SOCIETY has, in the death of General Orton, lost even more, for he was not only your founder, but your leader during a period of brilliant development of more than thirty-three years. We can only hope that the AMERICAN CERAMIC SOCIETY may continue to develop in the spirit of General Orton.

The German Ceramic Society will always hold him in honored memory as one of the outstanding ceramists to whom German science is greatly obligated.

With the expression of my highest esteem, I am,

Very respectfully yours,
GEHEIMRAT FELLINGER

LOCAL SECTION NEWS

Baltimore-Washington Section[1]

A meeting of the Baltimore-Washington Section was held April 2, 1932, at the Tilden Gardens Club Building, Washington, D. C.

Moving picture films showed in detail the various steps in the manufacture of porcelain enamel frit, large enameling plants in the Middle West, and the continuous enameling department of a refrigerator manufacturing plant.

E. N. Bunting, Bureau of Standards, Washington, D. C., spoke on "Phase Equilibria and Method of High Temperature Measurement."

He discussed the types and limitations of the heating systems employed in the laboratory, the difficulties encountered in temperature control, and the reactions taking place at these high temperatures, with particular reference to the oxides of silicon, aluminum, chromium, and zinc. An incentive for part of this study was the development of refractories such as those used in the smelting of zinc.

Pittsburgh Section

The next meeting of the Pittsburgh Section will be held at New Castle, Pa., May 10, 1932. Plant trips will be scheduled for the afternoon with a dinner and technical talk at the Castleton Hotel in the evening.

A meeting was held April 12 at Mellon Institute, Pittsburgh, Pa. Sixty members were present. F. W. Preston and H. E. White spoke on "The Way Things Break." About one hundred samples were broken in tortional and transverse bending, including

[1] Joseph F. Klekotka, *Secretary-Treasurer*.

glass and refractory bodies. The point to be made was that all things always break in tension which was proved by the experiments. Stereopticon slides were shown which included three interesting microphotographs of surface breaks in glass.

Plans for the Annual Meeting of the SOCIETY to be held in Pittsburgh, February 12–18, 1933, were discussed.

The officers of the Pittsburgh Section are as follows:

Chairman: Hobart M. Kraner *Secretary:* H. G. Wilcox
Vice-Chairman: H. H. Blau *Treasurer:* Jack H. Waggoner

NEW MEMBERS RECEIVED IN FEBRUARY AND MARCH

PERSONAL

Robert William Ball, Chemist, du Pont Experimental Station, Wilmington, Delaware.
J. C. Swearengen, Chemist, Hazel-Atlas Glass Co., Zanesville, Ohio.
Frank R. Valentine, 150 Green St., Woodbridge, N. J.; President, M. D. Valentine & Brother Co.

STUDENT

Byron W. Merwin, Iowa State College, Ames, Iowa.

Membership Workers Record

Personal: F. C. Flint 1, C. H. Peddrick, Jr., 1, Office 1. *Student:* D. A. Moulton 1. Total, 4.

ROSTER CHANGES FOR FEBRUARY AND MARCH

CORPORATION*

Standard Sanitary Mfg. Co., Research Division (Erwin Sohn, Director), 1541 South Seventh St., Louisville, Ky. (Pittsburgh, Pa.)

PERSONAL*

Anderson, Y. R., 507 Lansdowne Ave., Saskatoon, Sask., Canada. (Estevan, Sask., Canada.)
Beasley, Herbert C., Servel, Inc., Evansville, Ind. (Ingram-Richardson Corp., Bayonne, N. J.)
Bloor, Colin A., Universal Clay Products Co., Sandusky, Ohio. (110½ E. Main St., Peru, Ind.)
Brown, Wilbur F., Libbey-Owens-Ford Glass Co., Charleston, W. Va. (Toledo, Ohio.)
Diver, Mortimer L., P. O. Box 265, Millburn, N. J. (P. O. Box 1073, San Antonio, Texas.)
Dufour, George, 54 Rue Ducret, Aniche, Nord, France. (50 Rue Harmand, Haiphong, Tonkin, French Indo-China.)
Edwards, Harry, 1 Sant Street, Burslem, Stoke-on-Trent, England. (Dundas Cottages, Bonnybridge, Scotland.)
Foster, Harry D., The National Fireproofing Co., Haydenville, Ohio. (Ohio State Univ. Eng. Experiment Station, Columbus, Ohio.)
Grogan, Glenroy G., 308 S. Wapello Ave., Mt. Prospect, Ill. (6787 Olmsted Ave., Chicago, Ill.)
Irvine, George C., 732 Seventh St., Niagara Falls, N. Y. (221 Wyandotte Ave., Cleveland, Ohio.)

---

* Addresses within the parentheses () represent the old addresses.

These Roster Changes which are published each month may be checked against the complete Membership Roster which appeared in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

Ives, John B., 2805 Rathbun Dr., Toledo, Ohio. (Laclede-Christy Clay Products Co., 4976 Mardell, St. Louis, Mo.)
Kuechler, A. H., 50 Richards Road, Columbus, Ohio. (Cloverport, Ky.)
Mitchell, Alfred A., 3840 Campbell St., Kansas City, Mo. (Box 559, Rolla, Mo.)
Ogden, Ellsworth P., 1957 Chelsea Rd., Columbus, Ohio. (Freyn Engineering Co., % Kuznetskstroy, Kuznetsk, Siberia, U.S.S.R.)
Parmelee, Cullen E., Carrier Engineering Corp., 1596 Arcade Bldg., St. Louis, Mo. (1824 Union Trust Bldg., Cleveland, Ohio.)
Richardson, Gordon B., Livermore, Calif. (W. S. Dickey Clay Mfg. Co., 116 New Montgomery St., San Francisco, Calif.)
Schurecht, H. G., Eastern Terra Cotta Co., 401 Vernon Ave., Long Island City, N. Y. (85 Union St., Rahway, N. J.)
Sladek, George E., U. S. Encaustic Tile Works, Indianapolis, Ind. (Rossman Corp., Beaver Falls, Pa.)
Spires, Stephen T., Lavino Refractories Co., Womelsdorf, Pa. (New Straitsville, Ohio.)
Stowe, G. T., E. J. Lavino & Co., Bullitt Bldg., Philadelphia, Pa. (Leader Bldg., Cleveland, Ohio.)
Uhrmann, C. J., 134 N. Elm St., Hinsdale, Ill. (4212 Gilbert Ave., Western Springs, Ill.)
Westmont, O. B., Celite Products Co., Lompoc, Calif. (address formerly unknown).
Willson, B. W., Cherry Lodge, Zillah, Wash. (522 N. Jefferson Ave., Mason City, Iowa.)

NECROLOGY

S. M. Kier

The refractories industry lost one of its important and highly respected members in the death on February 17 of Samuel M. Kier, president of the Kier Fire Brick Co., Salina, Pa., and vice-president and a director of the General Refractories Co., Salina.

S. M. KIER

Mr. Kier was born in Pittsburgh, Pa., on January 10, 1876. He was graduated from the Western University of Pennsylvania and took a postgraduate course in electrical engineering at Purdue University. He was employed by the Westinghouse Electric & Mfg. Co. prior to entering the services of the Kier Fire Brick Co., a firm that had been organized in 1845 by his grandfather, Samuel M. Kier. Mr. Kier was made president of this company in 1905 and held that position until his death. He was a director of the American Refractories Institute.

Mr. Kier was a member of the AMERICAN CERAMIC SOCIETY for several years, always aiding and encouraging. He will be sorely missed.

Burrows Sloan

The refractories industry suffered another loss in the death of Burrows Sloan, who died in Philadelphia on February 28, 1932. Mr. Sloan was graduated from Princeton in 1899. He was employed by the Reading Company and subsequently became asso-

ciated with Harbison-Walker Refractories Company until 1911, when, together with the late Governor Sproul of Pennsylvania, he organized the General Refractories Company. Prior to his death, he was elected vice-president of this Company in 1920, president in 1924, and chairman of the Board of Directors in 1931. He had served on the directorate of the Company since November, 1912. Mr. Sloan became a member of the AMERICAN CERAMIC SOCIETY in 1930. He was fifty-five years of age at the time of his death.

BURROWS SLOAN

Mrs. E. W. Washburn

A large circle of friends and acquaintances will be grieved to learn of the death of Mrs. Edward W. Washburn on February 24 in Washington, D. C. Mrs. Washburn had not been in good health for a number of months but was acutely ill for only a brief time.

NOTES AND NEWS

G. E. F. Lundell Receives Hillebrand Award

At a meeting of the Washington Chemical Society held February 11, 1932, the Hillebrand award was given to G. E. F. Lundell, of the Bureau of Standards, for his work in connection with the outstanding book, Applied Inorganic Analysis. This award is given annually for the greatest contribution made by a Washington chemist during the year.

HERE IS AN ENTERPRISING CERAMIC SCHOOL

Ceramic Engineers at North Carolina State Win Award

BY JOHN H. ISENHOUR

True to the tradition it has established of being "up in front" at the annual Engineers' Fair, the Department of Ceramic Engineering at North Carolina State College this year again won the highest award for the individual exhibit. The award was made to E. C. Davidson, an outstanding senior and president of the North Carolina Chapter of Keramos, for his exhibit of approximately 50 pieces of art pottery which won unstinted praise not only of the judges but the 3500 visitors to the department. Davidson also won the award last year when he and C. C. Morrison exhibited together. This is the third year in succession that the department has won the individual exhibit award.

While the cup for the best departmental exhibit won last year passed into the hands

of the Chemical Engineers, the ceramic exhibit was, the visitors agreed, the best ever put on by the department. The art pottery exhibit, consisting of over 150 pieces, was made by the students outside of class hours. Original designs and copies finished in bright, crystalline, stoneware, and mat glazes were shown. Among those attracting

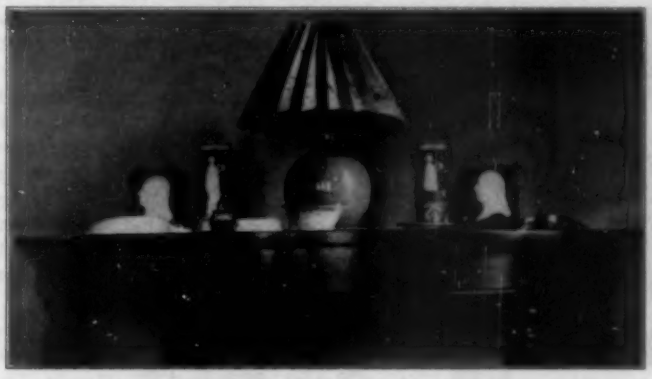


FIG. 1.—"Wedgwood" jasper ware made by ceramic engineers at North Carolina State College under direction of A. F. Greaves-Walker.

the most attention were several copies of the famous blue and white Wedgwood jasper ware. The souvenirs presented to the visitors were plaques and small vases in Wedgwood jasper.

In the industrial exhibit room was a display of dinnerware showing the different types of bodies from earthenware to porcelain produced in the United States, England, France,

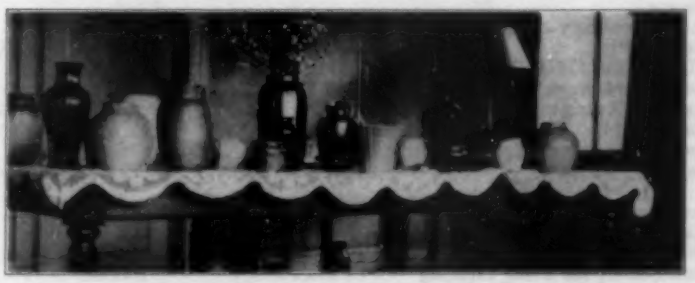


FIG. 2.—Art pottery made by ceramic engineers at North Carolina State College.

and Germany. Exhibits of refractories, plate and laminated glass, chemical porcelain, floor and wall tile, and electrical porcelain were also shown.

In the laboratory a demonstration of pottery making from blunging to drying was shown. The demonstration which attracted the crowds, however, was sheet metal enameling. Post card size "Toncan" sheets with a fired white ground coat and an unfired green cover coat were presented to visitors for their signatures. The signed plates

were then fired and delivered to them. The enamel frits used were donated to the department by the Porcelain Enamel Manufacturing Company. The entire enamel demonstration was handled by seniors specializing in enameling.

The Keramos float made an impression in the "Parade of the Engineers" in downtown Raleigh on the night of March 31. The float was followed by the entire student body of the department burning green flares.

FIG. 3.—Keramos float in 1932 Engineers' Parade at North Carolina State College.

C. C. Morrison and George J. Grimes were the ceramic engineers on the Engineers' Council under whose direction the Engineers' celebration was put on. The department committee in charge of the ceramic exhibit and demonstration consisted of C. C. Morrison, E. C. Davidson, H. E. Craven, Jr., W. C. Bangs, George J. Grimes, and John Isenhour.

The senior class enjoyed greatly, and received much benefit from, the recent visit of Everett H. Shands, Physicist of the Porcelain Enamel and Manufacturing Company, who gave lectures and demonstrations on enameling over a period of three days. Mr. Shands was formerly a member of the Engineering faculty of North Carolina State College.

C. C. Morrison was recently awarded the Phi Kappa Phi key, the highest scholastic honor of the College.

CALENDAR OF MEETINGS

Organization	Date	Place
American Assn. for the Advancement of Science		
Summer Meeting	June 20–25	Syracuse, N. Y.
Winter Meeting	December 27–31	Atlantic City, N. J.
AMERICAN CERAMIC SOCIETY	February 12–18, 1933	Pittsburgh, Pa.
American Foundrymen's Assn.	May 2–6	Philadelphia, Pa.
American Gas Assn.	October 10–16	Atlantic City, N. J.
American Institute	May 5	New York, N. Y.
American Institute of Chemical Engineers	June 15–17	Schenectady and Corning, N. Y.
American Refractories Institute	May 18	Pittsburgh, Pa.
American Society of Mechanical Engineers	June 27–30	Huntsville, Ont.
American Society for Steel Treating	October 3–9	Buffalo, N. Y.
American Society for Testing Materials	June 20–24	Atlantic City, N. J.
Association of Iron and Steel Electrical Engineers	June 20–23	Pittsburgh, Pa.
Exposition of Chemical Industries	February 27–March 4, 1933	New York, N. Y.
National Assn. of Stove Manufacturers	May 8–13	New York, N. Y.
National Exposition of Power and Mechanical Engineering	December 5–10	New York, N. Y.
National Glass Distributors Assn.	December 6–8	New York, N. Y.
National Safety Council	October 3–7	Washington, D. C.
New Jersey Clay Workers Assn.	June	Asbury Park, N. J.
Scientific Apparatus Makers of America	May	Wernersville, Pa.
Taylor Society, Inc.	December 7–9	New York, N. Y.

"PITTSBURGH'S WELCOME TO THE WORLD"

HOTEL WILLIAM PENN

Center of The Ceramic Industry

Largest Hotel Outside Chicago and New York

Welcomes The

AMERICAN CERAMIC SOCIETY
and Related Organizations

FEBRUARY 12th to 17th, 1933

—o—

Complete convention facilities to have all sessions under one roof—thereby assuring one of the most successful Ceramic Meetings in many years.

—o—

1600 rooms with bath—rates $3.50 per day and up.

BUYERS' GUIDE

A

Alexite (Refractory Products)
Carborundum Co.

Alumina (Hydrate and Calcined)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.

Aluminum Oxide (Fused)
The Exolon Co.

Ammonium Bifluoride
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Ammonium Carbonate
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Antimony Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Automatic Stove Rooms
Philadelphia Drying Machinery Co.

B

Ball Mills
Hardinge Co., Inc.
Hommel, O., Co.
McDanel Refractory Porcelain Co.

Ball Mills (Laboratory Type)
Ceramic Color & Chemical Mfg. Co.
Hardinge Co., Inc.
Hommel, O., Co.

Barium Carbonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Barytes
Hommel, O., Co.

Batts
Carborundum Co. (*"Carbofrax Alexite"*)

Bitstone
Potters Supply Co.

Blocks (Refractory)
Carborundum Co.

Borax
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.

Borax Glass
Pacific Coast Borax Co.

Boric Acid (Anhydrous)
Hommel, O., Co.
Pacific Coast Borax Co.

Boric Acid (Crystal, Granular or Powder)
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.

Brickmaking Machinery
Hardinge Co., Inc.

Bricks (Refractory)
Carborundum Co. (*"Carbofrax Alexite"*)

Broken Glass
The Bassichis Co.

Burners (Nat. Gas)
Swindell-Dressler Corp.

C

Carbofrax (Refractory Products)
Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

The National Silica Co.

OREGON, ILL.

Producers and Pulverizers of

FLINT

exclusively for

Pottery Purposes

99.97% Pure Silica **140 Silk Lawn Test**

Ceramic Service? We Give It

We Manufacture—

- Pins
- Stilts
- Thimbles
- Spurs
- Saggers
- Crucibles
- Tile for Decorating Kilns

We Sell—

- Ball Clay
- Sagger Clay
- Wad Clay
- Ground Fire Clay
- Bitstone
- Fire Brick
- Imported Paris White
- Domestic Whiting

THE POTTERS SUPPLY COMPANY

EAST LIVERPOOL, OHIO

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Carbonates (Barium, Lead)
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Caustic Soda
Ceramic Color & Chemical Mfg. Co.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.

Cements
Carborundum Co.

Ceramic Chemicals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Ceramic Plant Equipment
Harrop Ceramic Service Co.
Philadelphia Drying Machinery Co.
Swindell-Dressler Corp.

Chromium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Clay (Ball)
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Hommel, O., Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
The Roessler & Hasslacher Chemical Co.
Spinks Clay Co., H. C.

Clay (China)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Edgar Brothers Co.
Hammill & Gillespie, Inc.
Hommel, O., Co.
Paper Makers Importing Co.

Clay (Electrical, Porcelain)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay Co.
Spinks Clay Co., H. C.

Clay (Enamel)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Hommel, O., Co.
Kentucky-Tennessee Clay Co.
Metal & Thermit Corp.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.

Clay (German Vallendar)
Ferro Enamel Corp.
The Roessler & Hasslacher Chemical Co.

Clay Miners
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay (Potters)
Old Hickory Clay Co.
Spinks Clay Co., H. C.

Clay (Sagger)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay Co.
Potters Supply Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay Tests
Harrop Ceramic Service Co.
Swindell-Dressler Corp.

Clay (Wad)
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wall Tile)
Kentucky-Tennessee Clay Co.
Old Hickory Clay Co.
Spinks Clay Co., H. C.

Clocks, Gauge Board
Ferro Enamel Corp.

Cobalt Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Numerical Documentation

THE ANNUAL TABLES OF CONSTANTS (A.T.C.)

AND NUMERICAL DATA

Chemical, Physical, Biological and Technological

collect, classify and publish since 1910 everything in Pure and Applied Natural Sciences liable of being expressed by a number.

(For the period 1910–1928) the **A.T.C.** *complete* and

(since 1928) *continue* the International Critical Tables (I. C. T.)

The **A.T.C.** are absolutely necessary to all scientists.

They represent
the only one complete documentation—the most inexpensive—the easiest to consult owing to an *Index* systematically arranged which enables one to locate *at once* the data required.

For any information—any specimen—any volume on free examination

Apply immediately to

Canada and U. S. A.
The McGraw-Hill Book Company, Inc.
370 Seventh Avenue
New York, U. S. A.

Other countries
M. C. MARIE
9, rue de Bagneux
Paris VI° France

Volumes published: 1st Series—I to V—1910–1922 (5383 pages) and Index
2nd " VI & VII—1923–1926 (3571 pages)

Specimens: Reprints of the following sections are sent free of charge: Spectroscopy—Electricity, Magnetism, Electrochemistry—Radioactivity—Crystallography, Mineralogy—Biology—Engineering and Metallurgy—Colloids—Wireless—Photography—Geophysics—Combustible gaseous mixtures, Powders and Explosives.

English versions: Beginning with Volume VII, all explanations to the tables are given in both English and French.

Up-To-The Minute Information

To find the best articles upon business, financial, technical, chemical, or engineering subjects consult the INDUSTRIAL ARTS INDEX in your nearest Public, Special or College library.

It is a monthly subject index to the contents of more than 200 important periodicals including JOURNAL OF AMERICAN CERAMIC SOCIETY. Previous bound, cumulated volumes index the contents of principal business magazines for the past 20 years.

The library will probably have just the magazines you wish, new or old. If not, we can supply them promptly and reasonably.

Periodicals Department

THE H. W. WILSON COMPANY

Compilers and publishers of indexes to periodicals

950–972 University Ave. **New York City**

The Journal of the Society of Glass Technology

A quarterly Journal containing original papers and abstracts of papers covering the whole field of Glass Technology.

ANNUAL SUBSCRIPTIONS TO SOCIETY (Including Journal)

Ordinary Members	**$ 7.50**
Collective Members	**15.00**
Price per Number to non-Members	**2.50**
Price per Volume (unbound) to non-Members	**9.00**

Forms of application for membership may be obtained from the American Treasurer of the Society, Francis C. Flint, Washington, Pa.

Address orders and inquiries to: The Secretary, Society of Glass Technology, The University, Sheffield, England

BUYERS' GUIDE (continued)

Colors
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel Co., O.
The Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

Conditioning Machinery
Philadelphia Drying Machinery Co.

Conveyers (Clay, Sand, Brick, etc.)
Philadelphia Drying Machinery Co.

Cornwall Stone
Hammill & Gillespie, Inc.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Cornwall Stone (Imported)
The Roessler & Hasslacher Chemical Co.

Crucibles (Filter, Melting, Ignition)
Potters Supply Co.

Cryolite
Hommel, O., Co.

Cullet
The Bassichis Co.

D

Decorating Supplies
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

Driers
Harrop Ceramic Service Co.

Driers (China Ware, Porcelain)
Philadelphia Drying Machinery Co.

Drying Machinery
Ferro Enamel Corp.
Hardinge Co., Inc.
Philadelphia Drying Machinery Co.

E

Electrical Porcelain
Old Hickory Clay Co.
Paper Makers Importing Co.

Enameling Equipment, Complete
Chicago Vitreous Enamel Products Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

Enameling Furnaces
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Enameling Iron (Sheet)
American Rolling Mill Co.

Enameling Muffles
Carborundum Co. (*Carbofrax*)

Enameling, Practical Service
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Enamels
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.

Enamels, Porcelain
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Engineering Service
Harrop Ceramic Service Co.
Swindell-Dressler Corp.

Equipment (Porcelain Enameling)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

Exolon (Refractory Products)
The Exolon Co.

ALPHABETICAL LIST OF ADVERTISERS

	Page
American Potash & Chemical Corp.	2
American Rolling Mill Co.	25
American Telephone & Telegraph Co.	4
Bassichis Co., The	19
Carborundum Co.	Inside Back Cover
Ceramic Color & Chemical Mfg. Co.	21
Chicago Vitreous Enamel Product Co.	5
Classified Advertising	14
Drakenfeld & Co., B. F., Inc.	Inside Front Cover
Edgar Bros. Co.	21
Edgar Plastic Kaolin Co.	21
Exolon Co.	2
Ferro Enamel Corp.	23
Hammill & Gillespie, Inc.	17
Hardinge Co., Inc.	5
Hommel, O., Co.	23
Journal of the Society of Glass Technology	11
Kentucky-Tennessee Clay Co.	1
McDanel Refractory Porcelain Co.	19
Metal & Thermit Corp.	Outside Back Cover
National Silica Co.	9
Old Hickory Clay Co.	14
Pacific Coast Borax Co.	19
Paper Makers Importing Co.	19
Penn, Hotel William	7
Pennsylvania Salt Mfg. Co.	17
Philadelphia Drying Machinery Co.	2
Philadelphia Quartz Co.	5
Porcelain Enamel & Mfg. Co	17
Potters Supply Co.	9
Professional Directory	14
Roessler & Hasslacher Chemical Co.	15
Simplex Engineering Co.	1
Spinks, H. C., Clay Co.	24
Swindell-Dressler Corp.	17
Tables Annuells de Constantes & Donnees Numeriques	11
Titanium Alloy Mfg. Co.	Center of Book
Vitro Mfg. Co.	23
Wilson, H. W., Co.	11

(When writing to advertisers, please mention the JOURNAL)

PROFESSIONAL DIRECTORY

THE SHARP-SCHURTZ CO.

Chemists for the Ceramic Industry

We have fully equipped laboratories at Lancaster, Ohio, U. S. A.

Petrographic Laboratory

W. Harold Tomlinson

Microscopic examinations. All petrographic work.

114 Yale Ave.
Swarthmore, Pennsylvania

Established 1836

BOOTH, GARRETT & BLAIR

Analytical & Consulting
CHEMISTS

Accurate analyses of all types of Ceramic Materials

Feldspar, Clay, Sand, Colors
Glass, Enamels, etc.

404-406 LOCUST STREET
PHILADELPHIA, PA.

The oldest commercial laboratory in America

Emerson P. Poste

Consulting Chemical Engineer

Analyses: Ceramic Raw Materials and Products, Fuels, Iron and Steel, etc.

Special Investigations: Physical and Chemical Tests on Enamel, etc.

Box 51, North Chattanooga, Tenn.

German Consulting Service

Dr. Hans Navratiel

Two years' experience in U. S. Translates literature, patents. Assists prosecution patent applications. Obtains industrial information.

Berlin-Charlottenburg, Fritschestr. 41.

CLASSIFIED ADVERTISING

Opportunity available for technically trained Ceramist, with good background of practical shop experience in sheet metal enamel plant. A knowledge of colors and their application further asset. Please answer in detail giving age, education, experience, etc. Address Box 137-E, American Ceramic Society, 2525 N. High St., Columbus, Ohio.

1918 - Kentucky Ball and Sagger Clays - 1932

Ball Clays—Uniform and dependable in color and shrinkage, remarkably clean, fine working properties, excellent drying qualities. High-fired strength eliminating much bisque loss, color: cream white, low shrinkage and water of plasticity, vitrify 8 to 9 cones.

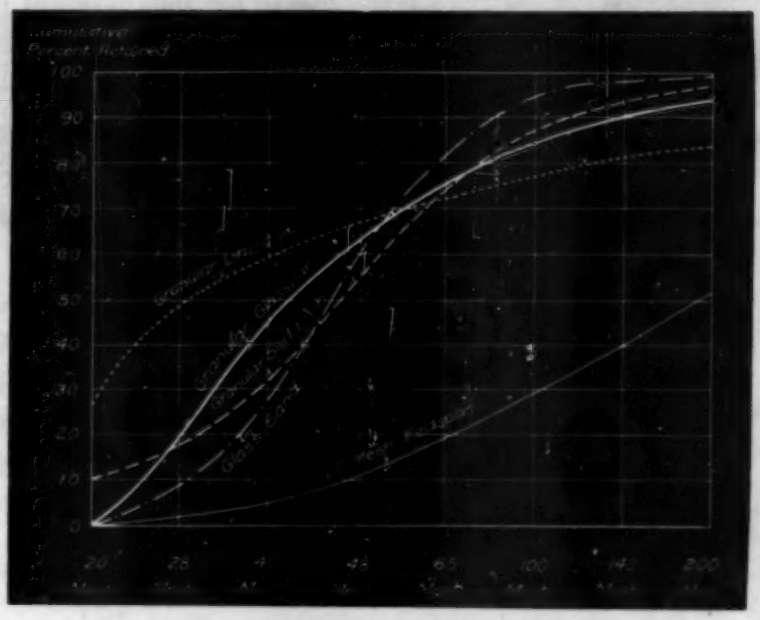
Sagger Ball Clay—A buff burning clay of high mechanical strength, 4600 lb. fired cone 9, water of molding plasticity 39%, drying shrinkage 8.9%. Used as standard in University laboratories for long life saggers. Several Tile and Refractory plants using in ware bodies.

Large Storage Bins—Clays shipped either lump or disintegrated, good clean clays and prompt service all periods of the year. Let us send you samples, freight prepaid.

OLD HICKORY CLAY CO.

Mines: Hickory, Kentucky — **Office: Paducah, Kentucky**
I. C. R. R. Co. — **Largest independent mine in the district.**

HOMOGENEITY in the Glass Batch— with GRANULAR GLASSPAR!



Comparative Screen Tests
of Four Major Glass Batch Constituents

IN a well-formulated glass batch the important materials—the Glass Sand, the Granular Soda Ash, the Granular Limestone and the *Feldspar*—bear a close physical relationship to each other. This insures homogeneity of the mix.

Look at the above chart. See how closely the curve for GRANULAR GLASSPAR follows the curves for the other 3 ingredients. No other feldspar shows such similarity. Now, look at the curve for a regular 20 mesh feldspar. See the marked difference in its distribution of particle size. Compare this feldspar curve with the GLASSPAR curve—then you will know why GRANULAR GLASSPAR enters the mix more evenly and perfectly, lessens batch separation and insures a homogeneous glass batch.

The
ROESSLER & HASSLACHER CHEMICAL CO.
INCORPORATED
Empire State Building, 350 Fifth Ave. New York, N. Y.
Sole Selling Agent for the UNITED FELDSPAR CORPORATION
(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

F

Fans
Philadelphia Drying Machinery Co.

Feeders, Constant Weighing
Hardinge Co., Inc.

Feldspar
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Fire Brick
Carborundum Co.

Flint
National Silica Co.
The Roessler & Hasslacher Chemical Co.

Flint Pebbles
Ferro Enamel Corp.
Hardinge Co., Inc
Hommel, O., Co.

Frit
Ceramic Color & Chemical Mfg. Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Furnace
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Harrop Ceramic Service Co.
Porcelain Enamel & Mfg. Co.
Simplex Engineering Co.
Swindell-Dressler Corp.

G

Glass (Broken)
The Bassichis Co.

Glass Tanks
Simplex Engineering Co.

Glass Plant
Simplex Engineering Co.

Glaze and Body Spar
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Glazes and Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Ferro Enamel Corp.
Hommel, O., Co.
Porcelain Enamel & Mfg. Co.
The Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

Glaze Spar
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Gold
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

H

Hearths
Carborundum Co.
(*Carbofrax* heat treating)

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.

I

Infusorial Earth
Harrop Ceramic Service Co.

Iron (Enameling)
American Rolling Mill Co.

K

Kaolin
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

PEMCO

PORCELAIN ENAMEL

For:
REFRIGERATORS
RADIO RESISTORS
BUTCHERS' FIXTURES
STOVES--Gas, Electric, Coal
WASHING MACHINE TUBS
WALL AND ROOFING TILE
AUTOMOBILE MANIFOLDS
BARBERS' SUPPLIES
SANITARY WARE
REFLECTORS
TABLE TOPS
NOVELTIES
SIGNS

ALWAYS CONSULT PEMCO

PORCELAIN ENAMEL & MFG. CO.
Eastern and Pemco Aves.
BALTIMORE · MARYLAND
U·S·A.

Since 1848
Importers of

ENGLISH CHINA CLAYS
ENGLISH BALL CLAYS
CORNWALL STONE
TALC (STEATITE)

Dependable Qualities of Ceramic Materials for all Branches of the Industry

HAMMILL & GILLESPIE, INC.
225 Broadway
New York

The
DRESSLER TUNNEL KILN
is being used for
Saggerless Setting
in all types of Ceramic Work.

SWINDELL-DRESSLER CORPORATION
Pittsburgh, Pa.

PENNSYLVANIA SALT MANUFACTURING COMPANY

Executive Offices: Philadelphia, Pa.

Works: Philadelphia and Natrona, Pa., Wyandotte and Menominee, Mich. Tacoma, Wash.

Representatives:
New York Chicago
Pittsburgh St. Louis

PENNA. SALT MANUF'G. CO.
PURE
GREENLAND KRYOLITH
PHILADELPHIA, PA

BUYERS' GUIDE (continued)

Kilns
Harrop Ceramic Service Co.
Simplex Engineering Co.
Swindell-Dressler Corp.

Kilns (China, Decorating)
Drakenfeld & Co., B. F.
Hommel, O., Co.

Kilns (Electric)
Swindell-Dressler Corp.

Kryolith
Hommel, O., Co.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co

L

Leeds (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.

Leers (Low Heat, Muffle Type, Electric)
Simplex Engineering Co.

Linings (Furnace Refractory, Block Refractory Plate, Brick and Tile)
Carborundum Co.

M

Magnesia (Sintered, Calcined)
The Exolon Co.

Magnesite
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Manganese
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O. Co.
The Roessler & Hasslacher Chemical Co.

Metals (Porcelain Enameling)
American Rolling Mill Co.

Minerals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

Motors
Harrop Ceramic Service Co.

Muffles (Furnace)
Ferro Enamel Corp.
Carborundum Co. (*Carbofrax*)

Mullite (Artificial)
The Exolon Co.

Muriatic Acid
Pennsylvania Salt Mfg. Co.

N

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

O

Opacifiers
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.

Pyrometer Tubes—Protection Tubes—Combustion Tubes
McDanel Refractory Porcelain Company
Beaver Falls, Pennsylvania

UNUSUAL · SHAPES · OUR · SPECIALTY

CULLET
BUYERS AND SELLERS
The Bassichis Company
210 Society for Savings Bldg., CLEVELAND, OHIO

BORAX *Guaranteed 99½%–100% Pure* BORIC ACID
Select the Brand which has back of it years of *successful use* by experienced Ceramists
Pacific Coast Borax Co., New York
Chicago Los Angeles

FINEST POTTERY CLAYS

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Oxides
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Ferro Enamel Corp.
Hommel, O., Co.
Metal & Thermit Corp.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

P

Pebble Mills
Hardinge Co., Inc.
Hommel, O., Co.

Pins
Potters Supply Co.

Placing Sand
National Silica Co.

Plant Design
Harrop Ceramic Service Co.
Swindell-Dressler Corp.

Polariscope
Simplex Engineering Co.

Porcelain Enameling Service, Practical
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Porcelain Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Pot Furnaces
Simplex Engineering Co.
Swindell-Dressler Corp.

Potash (Carbonate)
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Potassium Bifluoride
Hommel, O., Co.

Producer Plants
Simplex Engineering Co.

Pulverizing Mills
Hardinge Co., Inc.
Hommel, O., Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
McDanel Refractory Porcelain Co.

R

Refractories
Carborundum Co.
The Exolon Co.

Refractory Materials
The Exolon Co.

Rutile
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.

S

Saggers
Carborundum Co.
Potters Supply Co.

Scrap Glass
The Bassichis Co.

(When writing to advertisers, please mention the JOURNAL)

WENNING
CERAMIC COLORS
TRADE MARK

"CERAMIC" COLORS

CERAMIC PRODUCTS ARE ECONOMICAL AND DEPENDABLE

USED BY LEADERS IN THE CERAMIC INDUSTRY

CERAMIC COLOR & CHEMICAL MANUFACTURING CO.

NEW BRIGHTON, PA., U. S. A.

OUR EXPERIENCED CERAMIC ENGINEERS WILL COOPERATE IN WORKING OUT SPECIAL COLORS

Remember—EDGAR CLAYS Have Characteristics That No Other Clays or Combination of Other Clays Can Produce.

Our Florida Clays* fully bring out the remarkable properties of Plastic Vitrox in the rapidly growing production of the new Vitrolon Ceramic Wares.

THE MORE OF OUR CLAYS YOU USE, THE BETTER WE CAN SERVE YOU.

* *(Tested and approved by Vitrefrax Laboratories)*

EDGAR PLASTIC KAOLIN CO.
Home Office—Metuchen, N. J.

EDGAR BROTHERS CO.
New York Office—50 Church St.

Mines in Georgia and Florida

BUYERS' GUIDE (continued)

Selenite of Sodium
Drakenfeld & Co., B. F.
Hommel, O., Co.
Vitro Mfg. Co.

Selenium
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Sheets (Enameling Iron)
American Rolling Mill Co.

Silica (Fused)
The Exolon Co.

Silicate of Soda
Ceramic Color & Chemical Mfg. Co.
Philadelphia Quartz Co.

Silicon Carbide
The Exolon Co.

Silicon Carbide Firesand
The Exolon Co.

Sillimanite (Synthetic)
The Exolon Co.

Slabs (Furnace)
Carborundum Co.

Smelters
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

Soda Ash
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

Sodium Fluoride
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Spar
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Spurs
Potters Supply Co.

Stilts
Potters Supply Co.

Sulphuric Acid
Drakenfeld & Co., B. F.
Pennsylvania Salt Mfg. Co.

T

Talc
Hammill & Gillespie, Inc.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Tanks
Simplex Engineering Co.

Tanks (Pickle)
Ferro Enamel Corp.

UNIFORMITY

Increases Profits
in Porcelain Enameling

Write us for Folder
telling *why*.
No obligation.

FERRO ENAMEL
CORPORATION
CLEVELAND
OHIO

Branches in Ottawa, Canada; Rotterdam,
Holland; and Birmingham, England

Imported

★ ITALIAN ★

FLUORSPAR

96-98%

•• *Best Quality on Market for Glass Houses and Enamels.*

Recognized for Whiteness and extreme low Iron content. ••

•• *Costs No More—Why use any Poorer Quality—*

ORDER A TRIAL LOT AND
CONVINCE YOURSELF. DO IT NOW.

Sole Agents

THE O. HOMMEL CO., Inc.
209 Fourth Ave., Pittsburgh, Pa.

VITRO

MANUFACTURING COMPANY

Corliss Sta.—Pittsburgh

Quality Enamels
for Steel and
Cast Iron

◇ ◇ ◇

Oxide Colors for
Enamelers

◇ ◇ ◇

Vitrifiable Glass
Colors of
Distinction

◇ ◇ ◇

Pottery Colors and
Glazes

◇ ◇ ◇

Chemicals
for
Glass and Enamels

URANIUM—COBALT
—CHROME

BUYERS' GUIDE (continued)

Tile (Refractory)
Carborundum Co. (*Carbofrax*)

Tile (Wall)
Ferro Enamel Corp.
Paper Makers Importing Co.

Time Cycle Controller for Tunnel Kiln Pushers
Swindell-Dressler Corp.

Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.

Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Titanium Alloy Mfg. Co.

Titanium Oxide
The Roessler & Hasslacher Chemical Co.

Tubes (Insulating)
McDanel Refractory Porcelain Co.

Tubes (Pyrometer)
McDanel Refractory Porcelain Co.

W

Wet Enamel
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
Vitro Mfg. Co.

Whiting
Drakenfeld & Co., B. F.
Hommel, O., Co.
The Roessler & Hasslacher Chemical Co.

Z

Zirconia
Ceramic Color & Chemical Mfg. Co.
Hommel, O., Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Mr. Ceramist—

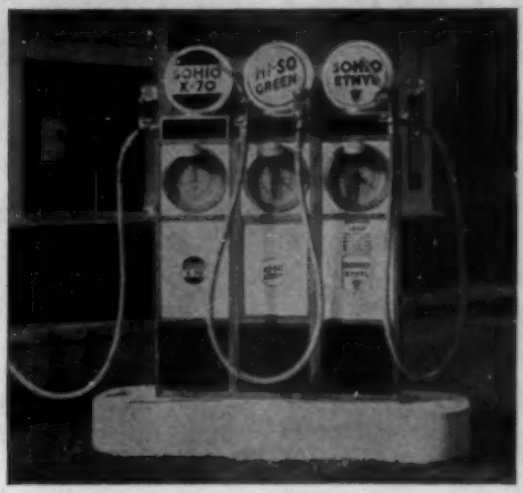
We have { ***The Clay*** / ***The Facilities*** / ***The Experience***

H. C. SPINKS CLAY CO.
Newport, Ky.

PORCELAIN ENAMEL

Beautifies

GAS PUMPS



PORCELAIN enameled iron triumphed again when owners of filling stations decided to replace the old-fashioned "gas monuments" with the new three-in-one pumps. Simple and more practical—yes; but also more attractive in their tri-colored porcelain enameled panels. Here, too, Ingot Iron contributes to profitable production and faultless pieces. There is no substitute for uniform analysis and a surface specially processed for *resultful* porcelain enameling.

THE AMERICAN ROLLING MILL COMPANY

Executive Offices: Middletown, Ohio

DISTRICT OFFICES: *Boston . Chicago . Cleveland . Detroit . Middletown*
New York . Philadelphia . Pittsburgh . St. Louis . San Francisco

ARMCO

INGOT IRON
The World's STANDARD
ENAMELING IRON

"PIONEERS IN CONTINUOUS SHEET ROLLING"

(When writing to advertisers, please mention the JOURNAL)

UNEXCELLED SALES MESSAGE MEDIUM

Is the *Journal of the American Ceramic Society*

It goes to those in the leading manufacturing plants who specify the materials and equipment used

---

It is a Journal owned and managed by your prospective customers

---

The Journal has a world-wide circulation

ADVERTISING RATES

SPACE	ONE INSERTION	THREE INSERTIONS	SIX INSERTIONS	TWELVE INSERTIONS
FULL PAGE	$60.00	$54.00	$48.00	$40.00
HALF PAGE	33.00	30.00	27.00	24.00
QUARTER PAGE	18.00	16.50	15.00	13.50
EIGHTH PAGE	9.75	9.00	8.25	7.50

Size of Space

Full Page	7½″x4½″
Half Page	3⅝″x4½″
Quarter Page	1⁷/₁₆″x4½″
Eighth Page	⅞″x4½″
2 Page Spread	same as 2 Full Pages.
Screen	140

Forms Close

15th day of preceding month

Copy Due

5th day of preceding month

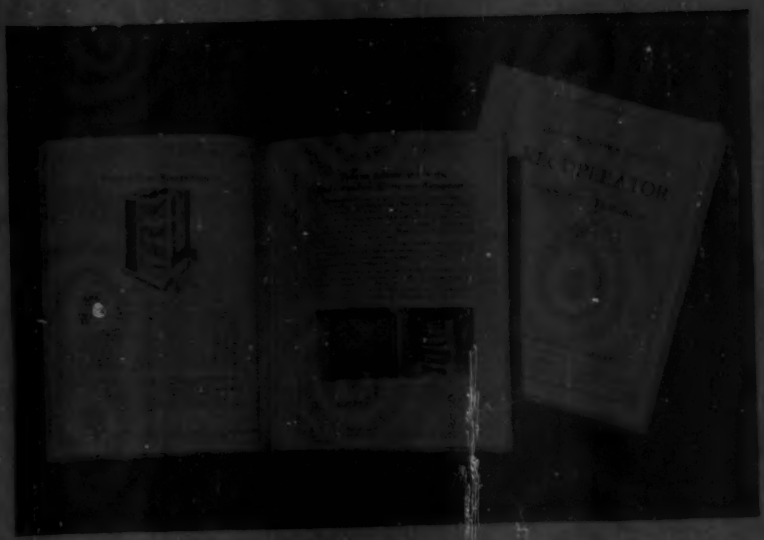
Preferred Positions

Inside Front Cover—List plus 20%
Opposite Table of Contents—List plus 20%
First Page before Articles—List plus 20%
End of Abstracts—List plus 10%
Center of Book—List plus 10%
First Page after Articles—List plus 20%
Opposite Inside Back Cover—List plus 20%
Inside Back Cover—List plus 20%
Back Cover—List plus 25%

The American Ceramic Society

2525 North High Street

Columbus, Ohio



IN THIS BULLETIN—

The complete story of The Carborundum Company Recuperators for Industrial Furnaces

WE know you will be interested in the engineering facts regarding The Carborundum Company Recuperators as published in this bulletin.

These recuperators, installed with furnaces used in the steel, malleable iron, copper, glass, porcelain enameling industries and with ceramic tunnel kilns, have definitely proved their general adaptability and dependability.

They involve a large variety of operating conditions, a wide range of temperatures, both in waste gases and preheated air, continuous and intermittent furnace operations and processes requiring the extremes of accuracy in control.

The outstanding feature of these recuperators lies in the use of "Carbofrax" tubes—But let the bulletin tell you the complete story.

Send for a copy—use the coupon.

THE CARBORUNDUM COMPANY

REG. U. S. PAT. OFF.

(Refractory Division)

PERTH AMBOY, N. J.

CARBORUNDUM AND CARBOFRAX ARE REGISTERED TRADE MARKS OF THE CARBORUNDUM COMPANY

THE CARBORUNDUM COMPANY, Perth Amboy, N. J.
Please send bulletin on "Carborundum Company Recuperators."

Name _____

Address _____

Get the kind of glaze you want with

M and T Tin Oxide

BRILLIANT and rich . . . snow white . . . free from specks and discolorations . . . that's the kind of a glaze you want, and that's the kind you always get with M and T Tin Oxide.

Hundreds of leading firms use M and T Tin Oxide exclusively because it brings the superior results they demand at an advantageous price.

Metal & Thermit Corporation

CERAMIC DEPARTMENT

HOMER F. STALEY • MANAGER
R. R. DANIELSON • DIRECTOR OF RESEARCH
120 BROADWAY, NEW YORK CITY